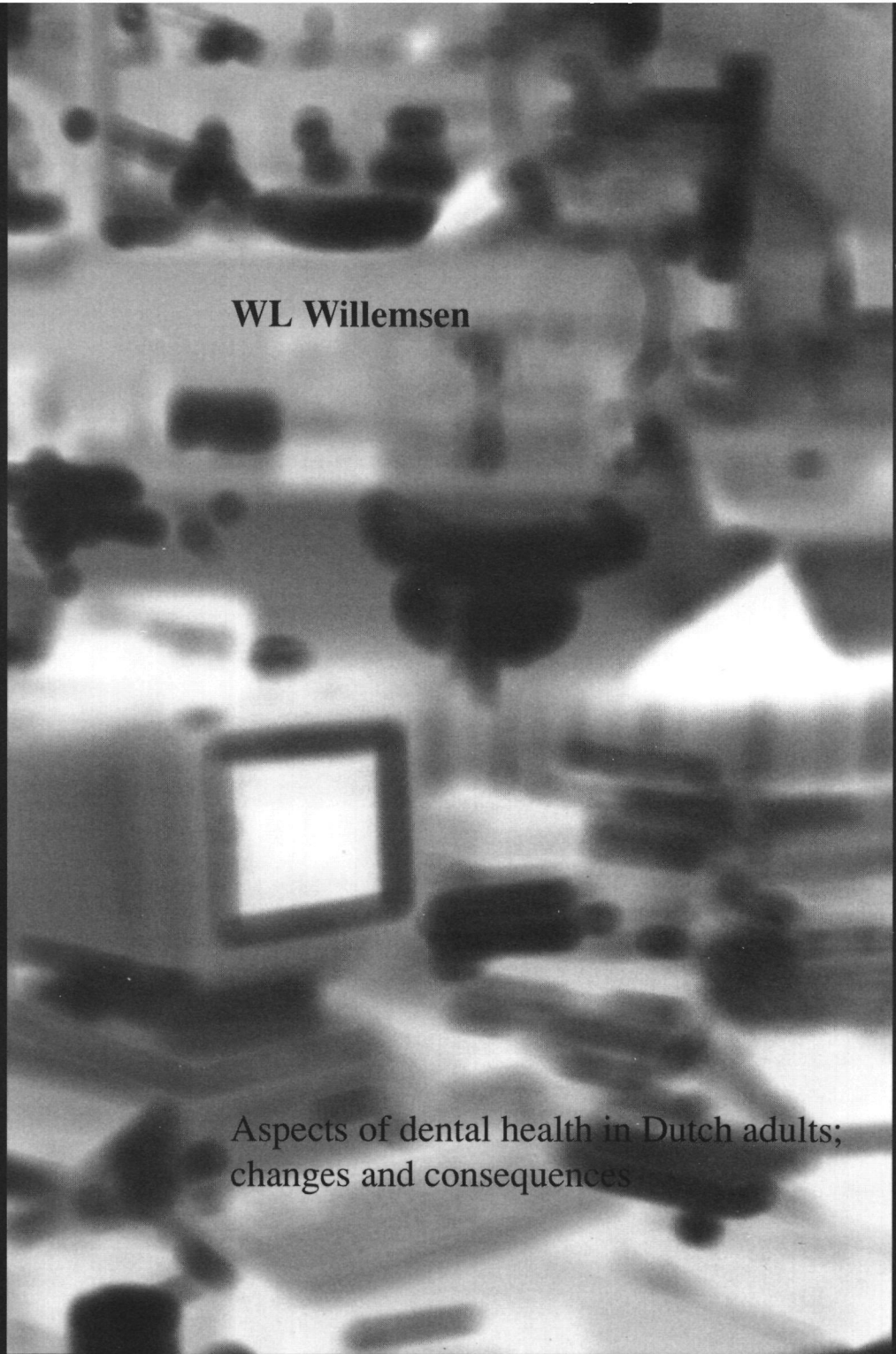

WL Willemsen

Aspects of dental health in Dutch adults; changes and consequences

Voor pa en ma

Aspects of dental health in Dutch adults; changes and consequences

Een wetenschappelijke proeve
op het gebied van de Medische Wetenschappen

Proefschrift

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"Plannen mislukken bij gebrek aan overleg,
maar door de veelheid van raadgevers komt iets tot stand"

Spreuken 16 : 22

Aspects of dental health in Dutch adults; changes and consequences

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Introduction

In the Netherlands the oral health status of young people has improved considerably over the last decennia. A decline in caries prevalence was accompanied by a rise in the number of caries free children (Truin *et al.*, 1981; Kalsbeek, 1982; Houwink *et al.*, 1985; Truin *et al.*, 1986; Truin *et al.*, 1991). With respect to periodontal diseases, gingivitis is said to be present in almost every adolescent, but hardly needing more than an instruction on oral hygiene in combination with the removal of calculus; periodontitis is found very infrequently and not expected to show a substantial increase in incidence (Kalsbeek *et al.*, 1989a; Frankenmolen, 1990). This results in a relatively minor demand for dental treatment out of this group (Frankenmolen, 1990; Truin *et al.*, 1992). The majority of dental treatments is performed in a small group of patients.

Considering the Dutch adult population, it was shown that dental caries, periodontal diseases, and their consequences can be found in almost every adult in the Netherlands (Truin *et al.*, 1988; Kalsbeek *et al.*, 1991; Karsten *et al.*, 1992). With respect to denture wearers, high percentages showing some kind of denture-induced pathosis are reported (Kalk 1979; Truin *et al.*, 1988; Kalsbeek *et al.*, 1989b; Van Rossum & Kalsbeek, 1985). However, uncertainty exists on developments in dental status and dental behaviour of the Dutch adult population, since hardly any longitudinal data are available on these aspects. Consequently, the views of the dental future of Dutch adults, and their dental treatment needs, are mostly dependent on private opinions, based for instance on status and developments in other countries. Data of epidemiologic studies performed for instance in the United States of America, or Scandinavian countries, can serve as reference for the Netherlands (Banting *et al.*, 1985; Hunt & Beck, 1985; Glass *et al.*, 1987; Brunelle *et al.*, 1988; Helöe *et al.*, 1988; Søgaard *et al.*, 1991).

It can be very hard, if not impossible, to integrate data from various sources to fit a specific topic, *e.g.*, developments in dental status and their consequences on demand for dental treatments in the Netherlands. Ambiguous results can be reached, and eventual effects may be different to the ones expected. A way of dealing with integration of knowledge is the use of so-called simulation studies: various types of models can be used to simulate and address a specific problem or topic observed in reality (Dunn, 1981; Truin, 1982; Geurts & Vennix, 1989a; Klabbers *et al.*, 1989; Vennix, 1990). Often, computers are used to calculate the values of variables and relations, as well as possible future developments of the system the particular model is simulating.

The collection of population data on dental health behaviour and dental health status is fundamental in planning community dental health programs, in monitoring changes in dental health and in evaluating the effects of the programs (Siegal *et al.*, 1988). It is therefore the aim of this thesis to study developments in aspects of dental health behaviour and dental health status in Dutch adults, and to study the influence of these developments on future dental health.

Longitudinal data on dental health in Dutch adults are incorporated into a system dynamic computer model of the Dutch dental health care system to study the effects of these data on future dental health and dental health care in the Dutch adult population.

CHAPTER

1

Present situation and expectations

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1.1 Introduction

Following the outline as presented in the Introduction to this Thesis, this study starts with an inventory of the current dental health behaviour and dental health status of Dutch adults. Trends over the last decennia to arrive at the current situation, as well as expected developments in future, will be addressed. Their possible consequences for dental health care will be mentioned. Dental disorders occurring only infrequently, occurring in population subgroups, or having minor implications for adult dental health care, will not be included; mandibular dysfunction (Truin *et al.*, 1988; De Kanter, 1990), orthodontics in adults (Burgersdijk *et al.*, 1991b), denture-induced mucosal pathology (De Baat & Kalk, 1989; Kalsbeek *et al.*, 1989b), oral cancer (Stoelinga *et al.*, 1990), and tooth wear will not be a topic in this study.

1.2 Oral self care

The prevention and treatment of dental diseases is to a large extent dependent on the willingness of the individual to maintain adequate oral self care behaviour. Oral self care behaviour comprises activities such as self-diagnosis, self-prevention and self-treatment, and seeking professional care (World Health Organisation, 1986; Glavind & Nyvad, 1987). It has been recognised that knowledge about dental health is but poorly associated with most preventive behaviours, and that presence of dental diseases is not necessarily perceived as constituting a need for dental treatment (Rayant, 1979; Reisine & Bailit, 1980; McCaul *et al.*, 1985; Bader *et al.*, 1990). Improvements in oral self care have been reported over time (Frandsen, 1985; Sheiham *et al.*, 1985; Søgaard, 1987; Helöe *et al.*, 1988; Søgaard *et al.*, 1991; Swinkels, 1993).

1.2.1 Present situation

In the Netherlands, approximately 2.5% of the adult population does not brush the teeth; in the age group 65–74 years, this is 8% (Nederlands Instituut voor Publieke Opinie en Marktonderzoek, 1986; Visser *et al.*, 1988; Heling, 1990). This figure has been more or less stable for a decade (Crielaars, 1977). Corresponding figures were found in other European countries (Gift, 1986; Athanassouli *et al.*, 1990; Søgaard *et al.*, 1991). It is concluded that daily tooth brushing is a social norm (Traeen & Rise, 1990). In the Netherlands, the average frequency of tooth brushing is 1.9 times a day. The use of a dentifrice was reported by 96% of those brushing their teeth; in 89% with a fluoridated dentifrice (Visser *et al.*, 1988; Heling, 1990). Considering the use of interdental cleaning aids, 31% of the dentate Dutch population uses dental floss, and 29% tooth picks. Those of higher ages (55–74 years) have the lowest scores of using interdental cleaning aids: 42–49% (Heling, 1990); however, these elderly people cannot be considered to constitute a high-risk group (Klüter, 1989). Contrary

to daily tooth brushing, the use of interdental cleaning aids is not considered to be a social norm (Traeen & Rise, 1990); hence a variety of reported figures. Søgaard *et al.* (1991) report of 17% of Swedish dentate individuals using dental floss, and 37% using tooth picks. In 1985 these figures were 27% for dental floss, and 43% for tooth picks (Rise & Søgaard, 1988). In a survey among two communities in Northern Ireland, 15% of the questioned persons were using an interdental cleaning aid (Keogh & Linden, 1991). Among adult Finns, 3% uses dental floss, and 25% tooth picks (Murtuomaa *et al.*, 1984). With respect to nutritional behaviour, only 8% of the Dutch population says to limit the amount of sweet snacks between meals because of possible negative dental implications; at the same time, 70% reports never to worry about it (Visser *et al.*, 1988; Heling 1990). Keogh & Linden (1991) found 13% of dentate individuals reporting to purposely avoid sweet snacks between meals to help preserve their teeth. In the Netherlands, an average of 8 sweet snacks is taken on a daily basis; with age, the frequencies of taking high amount of sweet snacks (11 times a day or more) decreases, whereas that of taking no sweets in between increases (Visser *et al.*, 1988; Heling, 1990). The latter is confirmed by other studies (Traeen & Rise, 1990). It is concluded that personal and social processes, *e.g.*, adherence to group norm, avoidance of excess of calories, pleasantness of taste, govern the sugar consumption among adults rather than a desire to avoid dental disease (Freeman, 1984; Traeen & Rise, 1990).

With respect to dental attendance, in 1981 61% of the total Dutch population visited the dentist at least once a year; this percentage increased to 69% in 1988, and is 71% in 1990 (Swinkels, 1990; Swinkels, 1993). Referring to Dutch adults, the percentages of persons that visit a dentist at least once a year are: 91% in age group 18–24 years after which it steadily declines, until a sudden decline to 59% in age group 45–54 years and 20% among higher ages. The reason for not attending a dentist is, for the most part, the presence of complete dentures. Excluding edentulous adults, the figures regarding percentages of persons with dental visits are modified into a steady decline from 91% in age group 18–24 years to 80% in age group 55–64 years, after which it falls to 53% among the higher ages (Swinkels, 1990). Of these dental visits, 63% concerns a periodic dental check-up; this percentage decreases with age: 74% for adolescents, and 38% for persons over 65 years of age. In this latter age group, other important reasons for attending a dentist are the presence of sudden complaints (17%), and prolonged dental treatments (37%) (Swinkels, 1990). Older Dutch adults obviously use dental services less regularly than younger ones. This is especially true for edentulous adults (Schaub, 1982; Van Rossum, 1983): only a steady 11% of edentulous Dutch adults showed a yearly dental visit over the period 1981–1992 (Swinkels, 1993). Depending on the surveyed group of elderly, it is reported that 40% to 66% of edentulous people did not consult a dentist for over 5 years, and 25% had not seen a dentist since the insertion of the complete denture(s) (Kalk, 1979; Van Rossum & Kalsbeek, 1985; Visser *et al.*, 1988; Kalsbeek *et al.*, 1989c). But, as was shown, older dentate adults are also reported to visit a dentist less frequently than younger persons. Explanations for this effect are sought in a low level of importance given to the dentition

relative to the general condition, a financially declining situation, negative experiences with dental health care personnel in the past or those of family and relatives, and in a fatalistic opinion towards the remaining dentition (Kiyak & Miller, 1982; Van Rossum & Kalsbeek, 1985; Van Rossum, 1988; Van Rossum *et al.*, 1990).

1.2.2 Expectations

It has been shown that nearly everyone in Western Europe brushes the teeth as a daily routine (Gift, 1986); the daily frequency, however, varies between individuals, as does the use of interdental cleaning aids (Traeen & Rise, 1990). This may also be true over time. A greater value assigned to the dentition, and an increasing confidence in the dental profession, are thought to result in a growing number of Dutch adults visiting a dentist more regularly in future (Schaub, 1982; Van Rossum, 1983; Van Rossum & Kalsbeek, 1985; Bouma, 1989). This expectation is already confirmed in that in 1992 the percentage of the total Dutch population that had visited a dentist at least once in the previous year, had risen to 73% (Swinkels, 1993). Subdividing this population into age groups: the percentage of older Dutch adults that had shown dental attendance had risen to 30%.

1.3 Dental caries

Dental caries can be divided between coronal and root caries. As to coronal caries, it is considered to be the result of interplaying ætiologic factors: the host, the microflora, the diet and the joint time of these factors (König, 1971; Edwardsson, 1986; Kilian & Bratthall, 1986; Theilade & Birkhed, 1986). Root caries is thought to be connected with these same factors, with a root surface exposed to the oral environment as prerequisite (Banting & Ellen, 1976; Hix & O'Leary, 1976; Ravald & Hamp, 1981; Katz *et al.*, 1982; Newbrun, 1986). Coronal caries has been considered to be a disease of the young, being of minor importance, when present, in adults (Dunning, 1979; Silverstone *et al.*, 1981). At present, a reduced caries prevalence with age is considered to be the result of a reduced number of remaining surfaces at risk (Tervonen & Ainamo, 1988), or the result of the various determinants wich influence the disease (Beck *et al.*, 1986; Fejerskov & Manji, 1990). With respect to root caries, it is reported to occur less frequently than coronal decay, and to increase in prevalence with age (Banting & Ellen, 1976; Katz, 1982; Vehkalahti, 1987a; Hand *et al.*, 1988); not so much as an effect of age itself, but rather as a reflection of increasing numbers of root surfaces becoming exposed (Baelum *et al.*, 1988a&b; Fejerskov *et al.*, 1993).

1.3.1 Present situation in young Dutch people

From 1970 to 1980, the caries prevalence in children and adolescents in the Netherlands was reduced by approximately 50% (Frankenmolen, 1990): the mean DMF-T index of 12-year-olds had decreased from 7.5 to 3.9. A further decrease to a DMF-T index of approximately 2 in 1990 is reported by Kalsbeek (1993). Similar results are reported in other European countries (Frankenmolen, 1990; Kalsbeek & Verrips, 1990). It is unclear whether this trend will continue upon ageing; the DMF-T index of 15-year-olds is higher than that of younger children, varying around 10 (Pot *et al.*, 1980; Kalsbeek, 1982; Houwink *et al.*, 1985). In a nationwide dental survey, performed in the Netherlands in 1986 (Van 't Hof *et al.*, 1991), it was found that the DMF-T index of 15–18-year-olds was 5.9, whereas it was 11.3 in age group 20–24 years (Frankenmolen, 1990). Regarding restorative treatments, 84% of the carious lesions had been filled; the remaining 16% of untreated carious lesions was present in 43% of the adolescents who participated in the survey. The mean caries incidence of Dutch adolescents over the period 1980–1986 was calculated at 1.6 tooth surface per year, as compared to 2.1 surfaces before 1980 (Frankenmolen, 1990).

With respect to coronal caries in dentate Dutch adults of 20–45 years, on average 2.4–3.6 carious coronal surfaces, and 19.6–29.6 filled surfaces are present (Kalsbeek *et al.*, 1991). In Table 1.1 these data are listed by various age categories.

Table 1.1 *Mean number of decayed and filled coronal tooth surfaces, and number of exposed, decayed and filled root surfaces, by age group (Source: Kalsbeek et al., 1991)*

Age group (years)	Coronal caries		Root surface caries		
	DS	FS	Exposition	DS	FS
20–24	2.4	19.6	2.5	<0.1	<0.1
25–29	2.9	29.6	4.9	0.2	0.2
30–34	3.6	28.0	7.7	0.2	0.3
35–44	2.6	28.9	12.4	0.5	1.0

When recalculating these counts to the level of teeth, they varied from 1.9–2.4 carious teeth and 8.8–11.9 filled teeth. These data are listed in Table 1.2. The relatively healthy situation in the youngest age group can be considered to be related to the decrease in caries prevalence among children and adolescents in the past; in older age groups probably too many teeth have already experienced decay in order for the DMF-T index to be favourably affected by preventive dental measures (Kalsbeek, 1993). A dental survey conducted in

1983 in a medium-sized town in the Netherlands revealed similar figures, albeit in a slighty different age group (30–44 years): 2.2 decayed teeth, and 9.7 filled teeth (Van Rossum & Kalsbeek, 1985). The need for restorative dental treatment in dentate adults is relatively low, as most of the DF-surfaces are filled (Kalsbeek *et al.*, 1991); however, this report is based on visual inspection only. A greater number of decayed surfaces might have been found had radiographs been used.

Table 1.2 *Mean DMF-T and components, by age group (Source: Kalsbeek et al., 1991)*

Age group (years)	DT	FT	DMFT
20–24	1.9	8.8	11.3
25–29	2.2	11.9	15.9
30–34	2.4	11.1	16.3
35–44	2.2	10.6	17.4

Since no representative data on the prevalence of dental caries in the adult population in the Netherlands before 1986 are available, no trends in age-specific DMFT-scores (or their components) can be observed. However, based upon data from selective surveys performed in the Netherlands between 1970 and 1980, it is estimated that a positive change has actually taken place (Truin *et al.*, 1993). When comparing these results with those from other European countries, similarities can be found (Kirkegaard *et al.*, 1986; Downer, 1993); upon comparison with the United States of America, however, the mean numbers of decayed teeth per person in the Netherlands are higher, which is also reflected in the mean DMFT-counts (Brunelle *et al.*, 1988; Miller *et al.*, 1988; Brown & Swango, 1993).

With respect to root caries in dentate Dutch adults, it is reported that the mean number of root surfaces exposed to the oral environment varies from 2.5 in the persons 20–24 years to 12.4 in the persons 35–44 years (Kalsbeek *et al.*, 1991). The number of carious root surfaces varies from ≤0.1–0.5 surface; the mean number of filled root surfaces varies from ≤0.1–1.0 surface. This means that only few of the exposed root surfaces actually become carious. In Table 1.1 these data are listed. It can be said that older Dutch persons on average have more decayed as well as more filled root surfaces than younger persons.

1.3.2 Present situation in older Dutch people

With the increasing number of elderly in the population and the retention of teeth into old age, dental diseases may become more of a problem in later life. Therefore, worldwide studies are being performed which are oriented towards a better understanding of the ætiology, course and epidemiology of oral diseases in old people, and towards the expected demands of oral health care from this group (Douglass & Gammon, 1985; Kandelman *et al.*, 1986; Beck, 1988; Miller & Karuza, 1988).

In 1986 the first nationwide dental survey was conducted in the Netherlands (Van 't Hof *et al.*, 1991). One of the objectives of the survey was to determine the prevalence of dental caries in the adult population. This paper describes the prevalence of coronal and root caries in elderly Dutch people.

Methods

Contact was made with individuals in a sample of 6577 persons aged 15–74 years, selected to represent the Dutch population by non-proportional stratified cluster sampling. The stratification factors were age, sex, socio-economic status (SES) and region; the degree of urbanisation was proportionally represented in each region. Of those contacted, 4496 were interviewed, and 3526 subsequently received clinical dental examinations. The examinations were completed during a half-year period in 1986. The aims of the study and a comprehensive description of the sampling procedure are described by Van 't Hof *et al.* (1991). For the present study the group of elderly persons was drawn from the total sample, and consisted of 1250 males and females. A subdivision was made into three age groups: 45–54, 55–64 and 65–74 years.

The clinical examinations were carried out by eight specially trained dentists, using a standard operating light, a dental probe, fibre optics (Volpi^{R}) and a mouth mirror. No radiographs were taken. The recording of coronal caries was done in accordance with the World Health Organisation criteria (WHO, 1977). However, a subdivision was made into primary caries (that which is not adjacent to a filling) and secondary caries (that which is adjacent to a filling); a full-mouth recording was used to record missing teeth. An alternate half-mouth recording of caries prevalence was made (upper right and lower left arches in one person, upper left and lower right in the next). Root caries was recorded when the distance from the cemento-enamel junction to the gingival margin was 1 mm or more, when the lesion was obviously soft, and more than half of it situated on the cementum (Katz, 1980). Root surface lesions were recorded as belonging to the buccal or lingual surface (border: contact area) of the teeth examined. Reproducibility of the clinical recordings

(inter-examiner agreement) was tested by re-examining 10% of the population examined. The Kappa statistic (Cohen, 1960) and the percentages of observed agreement were used to assess the reproducibility of the recordings.

Analysis of the data was performed with respect to the number of carious and restored coronal surfaces, and to the number of exposed, carious and restored root surfaces per person. To compare tooth position with caries prevalence, the mouth was divided into an anterior segment (containing teeth 1–3) and a posterior segment (containing teeth 4–7). Since older people had more missing teeth than younger ones, in order to maintain a standard base for comparison the counts for carious and restored coronal surfaces and for exposed, carious and restored root surfaces were also calculated as percentages of teeth present. The data were analysed using analysis of variance. Within each age group the effects of stratification factors and first-order interactions between these factors were tested. Due to selectivity with respect to participation, a fifth stratification factor (post-stratification) "dental attendance" had to be introduced (Van 't Hof *et al.*, 1991). Logistic regression analysis was used in the statistical analysis of root caries (Statistical Analysis Software, 1982). Statistically significant differences present between two or more age groups will be reported in the Results; those of only borderline significance will be excluded.

Results

For the reproducibility of the clinical recordings, the observed proportions of agreement were 0.99 for teeth present and 0.95 and 0.93 for coronal and root caries respectively. The Kappa values were 0.95 for teeth present and 0.73 for coronal as well as root caries.

With increasing age, the number of dentate subjects in the study population declined due to the increase of edentulousness (34.6, 49.2 and 65.4 *per cent* respectively in the three age groups). Significant differences ($p \leq 0.001$) were found between low and high SES groups; in all age groups the least proportion of edentulous subjects occurred in the highest SES groups, and the most in those groups of lowest SES. The dentate study population ($n = 576$) by age group, the mean number of teeth present in the study population, and the percentage of persons with one or more exposed root surface are shown in Table 1.3.

On average, the stratification factors revealed no statistical significance in the distribution of exposed root surfaces and of carious and restored coronal and root surfaces. However, "dental attendance" was statistically significant with respect to the number of teeth present in the anterior and posterior oral segments. On average, the posterior oral segment contained fewer teeth than the anterior oral segment (Table 1.3). In persons with exposed root surfaces teeth in the anterior oral segment were exposed less frequently than the posterior segment (Table 1.3).

Table 1.4 shows the results, in dentate subjects, for coronal caries (treated or untreated), and the percentage of carious and filled coronal surfaces by age group, type of caries, anterior or posterior oral segments and dental attendance. On average, the posterior oral segment experienced caries more frequently than the anterior oral segment. However,

Table 1.3 *Dutch subjects aged 45–74 years. The average number of teeth present and the percentage of persons with one or more exposed root surfaces by age group, type of caries, anterior/posterior position and dental attendance (dentate subjects only)*

Age group (years)	45–54 (n = 251)		55–64 (n = 196)		65–74 (n = 129)	
	Ant*	Post**	Ant	Post	Ant	Post
Teeth present	10.4	10.2	9.6	8.1	8.6	6.3
regular visitors	10.6	11.0	10.1	9.0	9.6	7.8
irregular visitors	9.9	8.4	8.5	6.5	7.3	4.4
Decayed surfaces	1.3	2.1	1.4	2.2	1.6	1.2
Filled surfaces	4.2	20.1	5.2	15.0	5.2	13.2
Percentage of persons with exposed roots	84.9	94.5	88.6	93.8	91.9	92.3

* Ant: anterior oral segment

** Post: posterior oral segment

among the subjects with caries, a higher percentage of tooth surfaces were carious in the anterior than in the posterior segments. There was a statistically significant difference between the percentage of filled coronal surfaces in anterior and posterior segments with dental attendance patterns; regular visitors had a higher percentage of teeth filled. The posterior segment was filled more frequently and contained a higher percentage of filled teeth than the anterior segment.

Table 1.5 shows the percentage of subjects with root caries (treated or untreated) and the percentage of carious or filled root surfaces in subjects with treated or untreated root caries by age group, type of caries, anterior or posterior oral segments and dental attendance. The percentage of subjects with root caries was low; only a few exposed root surfaces actually became carious or filled. The posterior oral segment contained a higher percentage of carious root surfaces than the anterior segment, which however had a higher proportion of teeth filled. Regular visitors had a higher percentage of teeth with filled root surfaces in the posterior oral segment than irregular visitors, and the difference was statistically significant.

Discussion

Since no oral radiographs were taken, the amount of approximal coronal and root decay that was recorded might have been underestimated. Also, fewer carious and filled surfaces

Table 1.4 *Dentate subjects: I, percentage of subjects with coronal caries (treated or untreated), and II, percentage of carious and filled coronal surfaces in these subjects by age group, type of caries, anterior/posterior position and dental attendance*

Age group (years)	45–54		55–64		65–74	
	I	II	I	II	I	II
Primary caries						
Anterior	20.7	7.3	19.4	8.2	17.1	8.9
Posterior	24.7	7.7	18.9	5.9	23.3	6.6
Secondary caries						
Anterior	21.1	6.5	17.9	8.5	12.4	9.5
Posterior	26.3	5.8	19.9	7.7	19.4	8.6
Filled surfaces						
Anterior	75.3	24.0*	61.7	23.3*	54.3	20.3**
regular visitors		25.4		22.7		22.5
irregular visitors		20.4		25.3		15.8
Posterior	83.7	24.4*	73.5	24.0*	60.5	23.0**
regular visitors		24.9		24.8		23.9
irregular visitors		22.9		21.5		21.5

* $p \leq 0.001$
** $0.01 < p \leq 0.05$

in elderly subjects might be the result of the extraction of teeth in a bad condition, *e.g.*, recurrent caries in heavily filled teeth, which could eventually lead to an edentulous state. Therefore the amount of teeth that have actually become carious is considered to be higher than reported.

With increasing age the number of dentate persons in the study population declined due to the increase in edentulousness. The differences in the proportion of edentulous persons found in the younger and older age groups can be attributed to the ageing process *per se*, but also to differences in dental treatment philosophies and applications in the past (generation effect): a shortage of dentists in the past could well have led to more teeth being extracted and consequently to more edentulous persons. In the present material, the increase of edentulousness could have resulted in a selection bias in that only relatively healthy (dentate) subjects were selected. This could account for the finding that the stratification factors in the dentate elderly people revealed on average hardly any statistically significant

Table 1.5 *Dentate subjects: I, percentage of subjects with root caries (treated or untreated), and II, percentage of carious and filled root surfaces in these subjects by age group, type of caries, anterior/posterior position and dental attendance*

Age group (years)	45–54		55–64		65–74	
	I	II	I	II	I	II
Primary decay						
Anterior	7.0	42.6	15.2	29.1	16.7	26.3
Posterior	21.4	32.5	1.7	27.1	30.2	28.0
Secondary decay						
Anterior	1.4	13.1	4.1	11.8	2.6	12.8
Posterior	6.7	22.2	10.2	20.3	7.3	28.5
Filled surfaces						
Anterior	17.8	27.3	16.4	23.4	21.1	31.2
Posterior	28.1	25.8*	33.1	23.0*	35.4	25.9*
regular visitors		26.1		23.3		27.5
irregular visitors		24.7		22.3		21.0

* $0.01 < p \leq 0.05$

differences, with the exception of "dental attendance"; persons who regularly visited a dentist had more teeth remaining and exhibited a higher proportion of filled teeth compared with those who visited a dentist irregularly, as would be expected.

The finding that the anterior oral segment had a higher proportion of coronal caries than the posterior might be explained by the somewhat higher percentage of filled posterior teeth, but it is more likely to be due to the greater number of extracted posterior teeth. With increasing age, the more a tooth is filled the more likely it is that it will be extracted because of caries, either in the crown or root; this is more likely in the posterior oral segment because of the high æsthetic value of the anterior one. This phenomenon would thereby reduce the percentage of decayed (and filled) posterior teeth. There is support for this explanation in the literature (Chauncey *et al.*, 1989).

The differences between the intra-oral distribution of root surface caries were marked. The posterior oral segment was decayed to a greater extent than the anterior oral segment, which is in agreement with other reports (Katz *et al.*, 1982; Kitamura *et al.*, 1986; Vehkalahti, 1987b; Hand *et al.*, 1988). This might be explained by the assumption that

root surfaces in the posterior oral segment become exposed earlier in life than those in the anterior; caries has had more time to attack exposed posterior root surfaces (Hand *et al.*, 1988). This could be aggravated by the fact that exposed posterior root surfaces cannot usually be seen directly by the patient and are difficult to clean, which could increase the risk of them becoming carious (Nyvad & Fejerskov, 1986; Vehkalahti & Paunio, 1988).

When comparing the Dutch results to those of other countries, *e.g.*, U.S. data (Graves & Stamm, 1985; Miller *et al.*, 1987), the elderly Dutch subjects exhibit a substantially higher percentage of edentulous persons (65 *vs.* 37 *per cent* respectively) whereas on average fewer teeth are present (14.9 *vs.* 17.9), with a greater proportion of carious surfaces (13.2 D/DFS *vs.* 6.9 D/DFS) and a lesser proportion of filled surfaces (86.8 F/DFS *vs.* 93.1 F/DFS). If it is assumed that the oral health status in the United States is better than in the Netherlands, this suggests that with a smaller percentage of edentulous persons in future, and fewer teeth missing in the elderly Dutch population, a rise in the proportion of filled surfaces might occur, with an eventual decline in the proportion of carious teeth. This assumption is supported by studies showing that elderly persons do not have less caries than younger ones (Beck *et al.*, 1985; Glass *et al.*, 1987; Reinhardt *et al.*, 1988; Chauncey *et al.*, 1989). This could lead to a changing pattern of dental disease because of an increase in the number of surfaces at risk for carious attack and subsequent fillings.

1.3.3 Expectations

Would the present low levels of caries progression in adolescents and young adults be maintained upon ageing, a progressively reduced caries prevalence could be found among adults in future (Downer, 1993; Truin *et al.*, 1993). However, the age-specific manifestations of coronal caries are expected to change. The opinion is that caries is being postponed from adolescence into adulthood, rather than that it is eradicated; consequently, "caries-free" would mean free from obvious carious lesions in need of operative treatment, but not necessarily free from the disease itself (Fejerskov *et al.*, 1993). At higher ages caries increments may be experienced, even though no changes in life-style conditions that influence the disease have taken place (Fejerskov *et al.*, 1993). Thus, young persons with relatively low caries prevalences might show an increase in the number of decayed surfaces in future. If this possible increase in the future occurrence of dental caries in adults is coupled with the finding that older adults as yet have not attained appreciable reductions in the occurrence of carious lesions, this would render coronal caries a major problem for the adult

population, requiring considerable restorative treatment efforts (Beck *et al.*, 1985; Graves & Stamm, 1985; Reinhardt *et al.*, 1988; Chauncey *et al.*, 1989; Plasschaert *et al.*, 1989; Beck, 1993). This phenomenon can be visualised by comparing numbers of decayed tooth surfaces in older adults with those in younger adults, in relation to the number of tooth surfaces present. On the other hand, it may be that the future increase in occurrence of dental caries is limited. Should older adults show a favourable change in the determinants that influence the disease, *e.g.*, an excellent level of oral self care and a change a nutritional habits, this could result in merely a marginal increase in the number of teeth experiencing decay (Graves & Stamm, 1985; Kitamura *et al.*, 1986; Newbrun, 1986). This phenomenon has already been reported (Brown & Swango, 1993). The presence of sound tooth surfaces at higher ages might not just be looked upon as an increase in the number of teeth at risk for carious lesions, but their very retaining might reflect a low caries progression rate (Fejerskov *et al.*, 1993). This can be further substantiated in that it is agreed that up to about 60 years of age, teeth are predominantly lost as a result of caries (Ainamo *et al.*, 1984; Baelum *et al.*, 1986; Chauncey *et al.*, 1989). Therefore, the more teeth retained, the more likely a low caries progression rate.

The expected developments of root caries in Dutch adults are uncertain (Van Rossum & Kalsbeek, 1985; Kalsbeek *et al.*, 1989d; König, 1990). It was found that, at present, the prevalence of root decay is higher in older than in younger adults. With increasing age the number of teeth with loss of periodontal attachment increases, resulting in a marked increase in the number of root surfaces accessible to carious decay (Baelum *et al.*, 1988a&b; Fejerskov *et al.*, 1991; Hugoson *et al.*, 1992; Beck, 1993; Fejerskov *et al.*, 1993). With an unaltered caries susceptibility and experience, this could result in an increase in the occurrence of root surface caries in future, with more teeth retained (Beck *et al.*, 1985; Banting & Ellen, 1976; Hand *et al.*, 1988; Reinhardt *et al.*, 1988; Vehkalahti *et al.*, 1983). On the other hand, it might well be that the very fact that more teeth are retained, is the result of an outstanding level of oral hygiene, and of a low caries progression rate, which may positively influence the future occurrence of root caries. There already is support for this speculation in the literature (Kitamura *et al.*, 1986; Beck, 1990; Fejerskov *et al.*, 1993). It was found that individuals with many teeth retained at high ages showed less root caries; those persons with only few remaining teeth were the ones experiencing new lesions (Beck *et al.*, 1988; Beck, 1993). Moreover, an association between the past caries experience and the risk of developing new root caries has been reported (Vehkalahti, 1987a; Fejerskov *et al.*, 1993): low past caries experience is correlated with a low root caries incidence.

Of importance with respect to the consequences of these possible trends in the occurrence of dental caries, is that the initiation and progression of carious lesions can be controlled (Fejerskov & Thylstrup, 1986; Newbrun, 1986; Nyvad & Fejerskov, 1986). With a controlled cariogenicity, the application of topical fluorides, the exposure to oral fluids, and with the patient performing thorough plaque removal — when needed supported by recontouring and smoothing surfaces — carious dentine surfaces could undergo remineralisation.

Such measures could restructure the need for operative dental treatment. However, should lesions be such in outline and depth as to hamper proper functioning, operative treatment should still be the method of choice (Fejerskov & Thylstrup, 1986; Newbrun, 1986; Nyvad & Fejerskov, 1986). The restorative material of choice for such lesions is shifting from amalgam to composites (Erickson, 1985). Using of composite in restorative dentistry will no doubt have a positive influence on the preservation of tooth structure; it may have a negative influence on the workload of the dentist in general practice, given the required treatment times (Fukushima *et al.*, 1988; Dilley *et al.*, 1990; Kreulen, 1992).

1.4 Periodontal diseases

Periodontal diseases can be divided in gingivitis and periodontitis. Gingivitis presents as a bleeding of the gingiva without apparent loss of periodontal attachment upon gentle probing, and it is said to represent the host's response to the plaque microbiota and its products (Taichman & Lindhe, 1989). Gingivitis is reported to decrease with age and to be less in each next birth cohort (Douglass *et al.*, 1983; Burt *et al.*, 1985). Where adequate oral hygiene is maintained, age seems to be of minor importance in its development.

Periodontitis presents as loss of periodontal attachment. In contrast with gingivitis, its prevalence and severity are mostly reported to increase with age. Additionally, it has not been established yet that succeeding birth-cohorts experience a decrease in the prevalence of periodontitis (Douglass *et al.*, 1983; Katz & Meskin, 1986; Capilouto & Douglass, 1988). Most likely, the severity of periodontal attachment loss reflects the accumulation of lesions over time: since periodontal pockets once formed do not spontaneously disappear, recurrent bursts of activity would of necessity result in the presence of more periodontal lesions in older than in younger people (Goodson *et al.*, 1982; Lindhe *et al.*, 1983; Page, 1984; Socransky *et al.*, 1985).

1.4.1 Present situation

In the Netherlands the percentage of teeth with gingivitis increases with age from 36% in age group 20–24 years to 58% in age group 65–74 years (Truin *et al.*, 1988; Karsten *et al.*, 1992). With respect to the percentage of persons with gingivitis: it is fairly stable from 86% in age group 20–24 years to 83% in age group 65–74 years. Similar results were found in studies among selective Dutch populations (Plasschaert *et al.*, 1976; Van Rossum & Kalsbeek, 1985). Considering the level of oral cleanliness, defined as the amount of plaque and/or supra- and subgingival calculus, the percentage of surfaces with plaque decreases with age, whereas those with calculus increases (Plasschaert *et al.*, 1978; Truin *et al.*, 1988): the percentage of surfaces with measurable plaque decreases from 41% in age group 20–24 years to 30% in age group 65–74 years; the percentage of surfaces with supra- and subgingival calculus increases from 19% in age group 20–24 years to 44% in

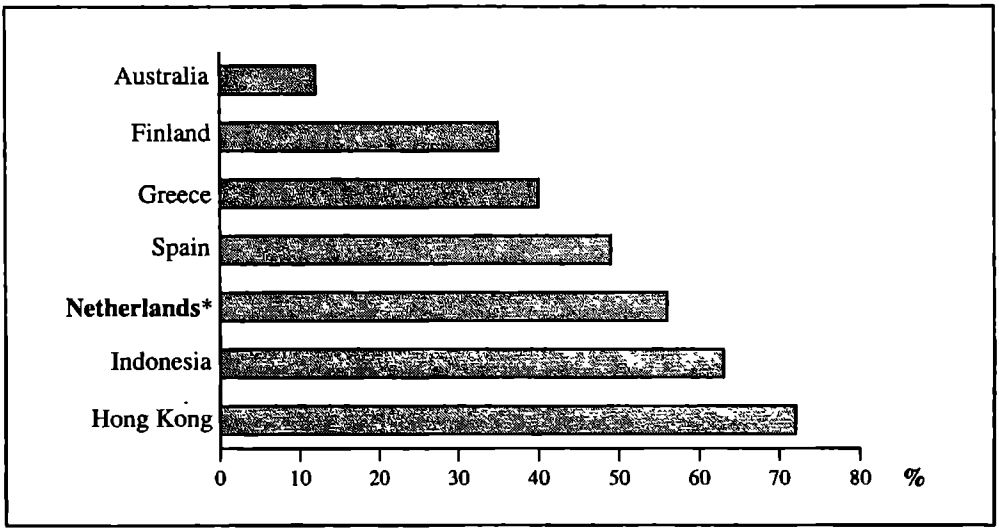
age group 65–74 years. With respect to the required treatments, it can be said that almost every Dutch adult needs some form of periodontal treatment, consisting of repeated oral hygiene instructions and scaling and rootplaning (Van Rossum & Kalsbeek, 1985; Truin *et al.*, 1988; Karsten *et al.*, 1992).

With respect to periodontitis, in the Netherlands the percentage of tooth surfaces with periodontal pockets of more than 3.5 mm increases from 5% in age group 20–24 years to 23% in age group 65–74 years (Truin *et al.*, 1988; Karsten *et al.*, 1992). The percentage of persons with deep pockets, *i.e.* more than 5.5 mm, is minimal in age group 20–24 years, *i.e.* 1%, but rises to 15% in age group 65–74 years. A demarcation can be noted in the prevalence of periodontitis with age. In young to middle-aged dentate Dutch adults (20–54 years), the presence of sound periodontal tissues decreases with age, whereas presence of periodontal pockets, with or without accompanying gingivitis and calculus, increases. However, among older Dutch adults (55–74 years) the reverse can be noted: presence of periodontal pockets with or without gingivitis and calculus decreases with age (Truin *et al.*, 1988). An analogous trend can be observed when considering the number of sextants per person to be treated for presence of periodontal pockets. In the young to middle-aged Dutch adults (20–54 years) it increases from 0.8 in age groups 20–24 years to 2.7 in age group 45–54 years. Among older Dutch adults (55–74 years) it decreases to 1.5 in age group 65–74 years. These phenomena are probably the result of the extraction of teeth in the worst condition; a chance which increases with age (Truin *et al.*, 1988; Kalsbeek, 1993). The overall percentage of persons with presence of periodontitis increases among young and middle-aged Dutch adults from 31% in age group 20–24 years to 61% in age group 45–54 years; it decreases among older Dutch adults to 55% in age group 65–74 years. Studies among other Dutch populations showed similar results, albeit not on a nationwide scale (Plasschaert *et al.*, 1976; Van Rossum & Kalsbeek, 1985). Marked variations on the prevalence of periodontitis, due to sampling procedures and data gathering, exist between various countries as analysed with data from the Global Oral Data Bank of the World Health Organisation; the Dutch data roughly in the centre of the range (Pilot *et al.*, 1986; Pilot *et al.*, 1992; Kalsbeek, 1993). In Figure 1.1 a selection of these data is presented. When comparing Dutch data with data from the United States of America, similarity is present regarding older adults, whereas the Dutch situation shows substantially higher prevalences among younger adults; these data are listed in Table 1.6 (Douglass & Fox, 1993).

1.4.2 Expectations

With the suggestion of a (further) improvement of oral hygiene in future, less gingivitis could be experienced (Douglass *et al.*, 1983; Douglass & Gammon, 1985; Holm-Pedersen, 1986a; Truin *et al.*, 1992). However, it is anticipated that periodontal diseases will manifest themselves in older Dutch adults, rather than in younger. Not so much because of a higher susceptibility, but rather because of the postponement of these diseases from adulthood to more advanced ages, as teeth are retained longer (Van Rossum, 1983; Plasschaert &

Figure 1.1 *Percentages of 35–44-year-old adults with periodontitis in various countries (Source: WHO Global Oral Data Bank, 1 July 1986)*



* Dutch data derived from Dutch National Dental Survey of 1986, after weighting to national data (Truin *et al.*, 1988)

Truin, 1986; De Baat & Kalk, 1989; Truin *et al.*, 1992). This could lead to an increase in the need for periodontal therapy (Van Rossum & Kalsbeek, 1985; Truin *et al.*, 1988). However, a similar consideration as for dental caries may apply to periodontal diseases, in that the very retaining of teeth reflects a healthy condition of teeth and surrounding tissues, and an adequate level of oral self care. This would lessen the likelihood of becoming periodontically involved, and thereby influence the increase in periodontal treatment needs in future. If it is assumed, as addressed already regarding dental caries, that the oral health status of United States adults is years ahead of that of Dutch adults, this theory is supported by the present prevalences of periodontitis which, especially among younger Dutch adults, are higher than those in the United States of America (Table 1.6).

Secondly, it can be seen from these results, that over time markedly fewer adults in the U.S. exhibited periodontitis. Possibly the prevalence of periodontitis did actually decrease, but it is considered more likely that the sampling and measurement methods of the last U.S. study have resulted in a substantial underestimation of the disease (Capilouto & Douglass, 1988; Douglass, 1989; Douglass & Fox, 1993). Thus, the actual decline in prevalence

of periodontitis was probably less than infered from the U.S. national surveys' results. It is suggested that even if the prevalence of periodontal diseases were declining as these results would suggest, a substantial proportion of this decline would be counterbalanced by the considerable increase in number of persons and number of teeth at risk of periodontal disease (Douglass & Fox, 1993). This seems to be confirmed by recent findings (Douglass *et al.*, 1993). The forecast that the periodontal situation considering presence of periodontal pockets for Dutch adults will remain fairly stable, follows this line of reasoning (Truin *et al.*, 1992).

Table 1.6 *Percentages of Dutch and United States adults with periodontitis, by age group*

Age group (years)	Netherlands	United States	
	Truin *et al.*, 1988	Kelly & Harvey, 1979	Brown *et al.*, 1989
20–24	31		
25–29	44	16	12
30–34	56		
35–44	56	33	17
45–54	61	38	19
55–64	52	47	21
65–74	55	59	23

Fortunately, the type of periodontal therapy needed most frequently is not complex: it consists of repeated individualised oral hygiene instructions and professional tooth cleaning (Douglass *et al.*, 1983; Holm-Pedersen, 1986b; Hunt, 1986; Capilouto & Douglass, 1988; Douglass & Fox, 1993). Treatments which can be provided by dentists as well as dental hygienists. The number of periodontal treatments needed is limited by the underestimation of the presence of periodontal diseases in general dental practice, and by the patients' demand for periodontal treatments being less than the epidemiologically estimated needs would imply (Gillings *et al.*, 1983; Bailit & Manning, 1988; McFall *et al.*, 1988; Douglass & Fox, 1993). Irrespective of the future developments in prevalence of periodontal disease, retaining a functional dentition into advanced ages should be possible, given the irregular nature and slowness of occurrence of actual periodontal tissue destruction (Beck *et al.*, 1984; Page, 1984; Hunt *et al.*, 1985a; Pilot, 1990).

1.5 Edentulousness

A continued decrease in the number of edentulous persons in each next birth cohort is noted in various studies (Hunt *et al.*, 1985b; Weintraub *et al.*, 1985; Meskin *et al.*, 1988). Tooth loss is considered not a factor of ageing *per se*, but rather to reflect oral hygiene status, treatment philosophies and accessibility of dental treatments of previous periods. Where adequate oral hygiene is maintained teeth may be retained, regardless of age (Beck & Hunt, 1985; Weintraub *et al.*, 1985; Meskin *et al.*, 1988; Fejerskov *et al.*, 1993).

1.5.1 Present situation

The percentage of edentulous Dutch adults varies from 4% in age group 16–44 years to 70% in the persons over 65 year of age (Swinkels, 1993). Remarkable differences between SES-groups are reported: the percentage of edentulous persons belonging to SES-low is at least twice that of those belonging to SES-high (Truin *et al.*, 1988; Kalsbeek *et al.*, 1991). A gradually decreasing percentage of edentulous people is noted in the Netherlands: from 32% of the total population being edentulous in 1981, it decreased to approximately 22% in 1992 (Van den Berg, 1982; Van den Berg, 1986; Central Bureau of Statistics, 1992; Swinkels, 1993). An increased dental awareness, and reductions in the shortage of dentists, have probably attributed to this decline in edentulousness (Kalsbeek, 1993). In Table 1.7 these data are listed.

Table 1.7 *Percentages of edentulousness in the Netherlands, by age group and period*

Period	Age group (in years)			Total
	16–44	45–64	≥65	
1981	9	54	78	32
1986	7	46	77	28
1990	5	37	70	24
1992	4	33	70	22

The prevalence of edentulousness is relatively high in the Netherlands, in comparison with other countries (Dowell & Scarrot, 1985; World Health Organisation, 1986b). In succeeding cross-sectional studies in Norway, the proportion of edentulous individuals fell from 16% to 12% over the period 1973–1985 (Helöe *et al.*, 1988). In an oral health study among

Swedish adults, the percentages of edentulousness in roughly similar age groups are lower than the Dutch. A similar percentage is reached for those over 79 years in the Swedish study: 70% edentulousness (Helldén *et al.*, 1989). In the United States of America, only 4% of the employed population between 18 and 65 years of age is edentulous, whereas it is 41% for the senior population (Miller *et al.*, 1987; Brunelle *et al.*, 1988).

In the Netherlands, on average, first complete dentures are inserted at 60 years of age (Truin *et al.*, 1992). The period during which these dentures are worn is rather long: two-thirds of the complete dentures are over 5 years old, with 20% being older than 20 years. The average age of the dentures is nearly 12 years (Visser *et al.*, 1988). Up to half of the people wearing dentures is reported to have flabby ridges, and this prevalence increases with increasing age (Kalk, 1979; Van Rossum & Kalsbeek, 1985; Truin *et al.*, 1988; Kalsbeek *et al.*, 1989b; Schulten *et al.*, 1989). The number of persons that regularly have their complete dentures checked and, when necessary adjusted or replaced, is small (Kalk, 1979; Van Rossum & Kalsbeek, 1985; Van Waas, 1985; Visser *et al.*, 1988): the percentage of edentulous Dutch adults not attending a dentist for over 5 years, is 66%. The remaining 34% had often done so to receive a new complete denture.

1.5.2 Expectations

It is expected that in the Netherlands the average age of becoming edentulous will shift from 60 years in 1986 to 66 in 2020, and that the percentage of people becoming edentulous will further decrease, eventually resulting in less edentulous persons who are edentulous for a shorter period of their life (Van Rossum, 1983; De Baat, 1990; Van den Berg, 1986; Bouma, 1989; Kalk *et al.*, 1989; Truin *et al.*, 1992). It is because of this phenomenon that the number of cases with severe alveolar ridge resorption is thought to lessen (Kalk *et al.*, 1989). The increased stability and retention for removable dentures, and the preservation of alveolar bone that can be attained by retaining roots or placing oral implants in the case of overdentures, could contribute to this decrease (Brewer & Morrow, 1975; Basker *et al.*, 1983; Ramselaar & Kruysen, 1985; Budtz-Jörgensen, 1991). However, overdentures could give rise to other dental disorders, *e.g.*, root caries and periodontal problems of the retained roots (Fenton & Hahn, 1978; Toolson & Smith, 1983; Shaw, 1984; Budtz-Jörgensen, 1991). Antibacterial products have proven to be succesful in maintaining these retained roots (Keltjens *et al.*, 1990). Consequently, the follow-up on overdentures has to be more strict, and would require more efforts and treatment time, than treatment with conventional complete dentures (Ettinger *et al.*, 1984; Kurer, 1986). The demand for complete dentures is thought to level with the present situation, as patients are expected to be more critical towards dentistry, will have their existing dentures adjusted or renewed more often, and will demand for dental implants more frequently; in the next millenium, the demand is expected to be less (Ettinger & Beck, 1982; De Baat & Kalk, 1989; Bouma, 1989; Kalk *et al.*, 1989; Kalk *et al.*, 1992; Truin *et al.*, 1992).

1.6 Conclusion

With respect to future dental developments in the Netherlands, opinions are diverging regarding the occurrence of dental caries and periodontal diseases, and their consequences on the resulting dental health care. There seems to be agreement on the expectation that more teeth will be retained into higher age. The prevalence of edentulousness will decrease, and the mean age of becoming edentulous will be raised. This will eventually result in a decline in the demand for complete dentures, and an accompanying decline in the occurrence of severe alveolar ridge resorption.

In the following Chapter, the methods to obtain longitudinal data on aspects of dental health in Dutch adults, to study changes in dental health behaviour and dental health status over the last years, will be addressed.

CHAPTER

2

Study design

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2.1 Introduction

The material and methods to study changes in dental health behaviour and dental health status in Dutch adults, are largely derived from, and depend on, a nationwide dental survey, conducted in the Netherlands in 1986. This Chapter will start with a short description of aspects of that latter dental survey, as far as they are of relevance to our present study.

2.2 The DNDS

In 1984 the Dutch national health administration decided to finance a nationwide dental survey: the Dutch National Dental Survey (DNDS). This in order to obtain representative data for the Dutch population aged 15–74 years, concerning the prevalence of oral diseases, the objective and subjective oral health needs, and oral self care and its determinants (Truin *et al.*, 1987; Van 't Hof *et al.*, 1991). After a pilot study in 1985, the actual DNDS was performed in 1986.

2.2.1 Sampling procedure

Due to the population concentration in the western part of the country, drawing a random sample would lead to an overrepresentation of this region of living, possibly hindering the assessment of regional differences within the Netherlands. Since also the fieldwork was to be concentrated in a few locations in order to obtain optimal participation of the inhabitants, a combination of cluster and stratification sampling was applied, in which the sample was stratified according to region and clustered around selected areas (Van 't Hof *et al.*, 1991). Four demographical characteristics were chosen as stratification factors, based upon their possible relevance to oral health, and the ease in their appliance. These factors were:

- *age groups*

15–19, 20–24, 25–29, 30–34, 35–44, 45–54, 55–64, and 65–74 years of age. Sampling equally distributed per age group (12.5%);

- *sex*

Each age group was to consist of 50% males and females;

- *socioeconomic status (SES)*

Based upon educational and occupational factors, and divided into Low, Middle and High classes. These classes should be equally sampled per age group (33%);

- *region of living*

The four regions (North, East, South and West) were aimed to be sampled equally (25%).

Thus, 192 cells were formed to subdivide the Dutch population. Representative figures would be obtained by weighting, because the distribution of the entire Dutch population over the chosen cells was known.

2.2.2 Data gathering

To realise the goals of the study, the DNDS was divided into two parts: a social or behavioural study, and a clinical dental study.

Within each region, 10 locations were selected to be visited, for a period of one week. The municipal administration was asked to deliver a complete list of inhabitants, taking into account the required distributions. The thus acquired possible participants were invited by letter to take part in the DNDS. One week later, the letter was followed by a home interview, to obtain information for the social part of the study. Participants were interviewed in their homes by professional, non-dental, interviewers. The interviews took about one hour, and aimed at assessing oral self care behaviour and its determinants. The questions addressed: oral hygiene behaviour, nutritional behaviour, dental attendance, dental curative decisions, and wearing behaviour of removable dentures (when present). Three basic variables were considered per investigated aspect: knowledge of oral self care, motives for specific behaviour and habits in performing oral self care (Truin *et al.*, 1987). "Socially desirable" answering to the interview was discouraged by giving short introductions to the questions, and by using a sequence in the questions that made socially desirable answers less likely. The questions used during the interview, the variables considered, and their construction, can be found in the reports on the DNDS (Truin *et al.*, 1987; Visser *et al.*, 1988). During the interview, the participants were asked to attend a clinical dental examination in a dental car. They were also asked whether they had objections to participate in follow-up studies on the DNDS, ensuring the possibility for acquiring longitudinal data of the Dutch adult population on the studied aspects.

The information for the clinical dental part of the DNDS, was obtained by clinical dental examinations. They took place in a dental chair of a dental car. Examinations were carried out by eight calibrated dentists. The examinations took on average half an hour per participant. A variety of oral health aspects was covered: the prevalence of coronal and root surface caries, the prevalence and quality of dental restorations, dental æsthetics, periodontal diseases, signs and symptoms of craniomandibular dysfunction, orthodontic disorders, mucosal disorders, and the quality of complete dentures. The variables used, and their construction for statistical procedures can be found in the reports on the DNDS (Truin *et al.*, 1987; Truin *et al.*, 1988). During the field study, about 10% of the sample was re-examined blindly. Apart from occasional exceptions, the percentages of agreement of the studied dental aspects varied between 70% and 99%, and the aspects that were studied showed an acceptable reliability (Truin *et al.*, 1988).

Data of both oral interview and clinical dental examination were obtained from 3526 persons, aged 15–74 years. Selectivity in participation was observed with respect to dental attendance for regular check-ups. Thus, the actual sample could not be considered to be representative for the distinguished strata in the Dutch population. In a post-stratification procedure (Betlehem & Kersten, 1987; Van 't Hof *et al.*, 1991), dental attendance was introduced as a fifth stratification factor.

In various articles, the results of the DNDS on the prevalence of dental disorders, dental attendance, dental behaviour, and dental treatment needs, have been reported (Frankenmolen, 1990; Heling, 1990; Kroeze *et al.*, 1990; Burgersdijk *et al.*, 1991a; Burgersdijk *et al.*, 1991b; Kalsbeek *et al.*, 1991; Visser *et al.*, 1991; De Kanter *et al.*, 1992; Karsten *et al.*, 1992).

2.3 The follow-up on the DNDS

It was decided to perform a follow-up on the DNDS in 1992. The main objective of this study was to detect and analyse changes among the Dutch adult population over the period 1986–1992. Changes in oral self care, dental attendance, aspects of oral health status, dental treatments, dental health behaviour and denture satisfaction were considered. The group of respondents of the DNDS of whom both social and clinical dental information was available, was the possible group of respondents for this follow-up study. Not included in the follow-up were the adolescents belonging to the 1986 age group of 15–19 years, because of an expected low response rate due to moving house, or to absence of motivation.

Since it was not feasible to perform another study as expensive as the DNDS, which costed 2.1 million Dutch guilders (approximately 1.1 million US dollars), it was decided to use a written questionnaire. Where applicable, the questions used would be in line with those of the DNDS-interview. In an accompanying letter the addressed persons were informed about the importance of the questionnaire in the gathering of longitudinal data. Reference was made to the DNDS of 1986 in which they had participated. They were asked to fill out the questionnaire and return it in a stamped addressed envelope within two weeks from receiving. A telephone number was given in case more information was needed, or when instructions needed explaining. Two types of questionnaires were constructed: one for those persons who according to the DNDS information were dentate in at least one jaw, the other for those who were edentulous.

2.3.1 Dentate population

The questionnaire for dentate persons included questions regarding person variables, dental attendance, oral self care, oral health status, dental treatments, and denture satisfaction (where applicable). In Appendix I the questionnaire is reproduced. The list of DNDS participants that met the criteria for inclusion into the follow-up, held 2180 dentate persons; of these, 876 persons were known to have lost interest in participating in follow-up studies on the DNDS. The remaining 1304 persons would include those turning out to be lost to follow-up due to unknown changes in address, or due to death.

Based upon positive experiences in other studies (Helöe, 1972; Könönen *et al.*, 1986; Douglass *et al.*, 1991; Palmqvist *et al.*, 1991), the questionnaire was to be supplemented with a form for self-assessment of the present dental status, to acquire information about

the number of teeth present, of crowns/bridges and of removable partial/complete dentures present, without having to perform a clinical examination. To evaluate the ability of lay people to fill it out accurately this form was tested in a pilot study, using new patients to the Dental School of the University of Nijmegen as they were considered to have on average a similar dental knowledge as the persons later to be addressed with the form. Fifty new patients were asked to fill out the form according to their present dental status. In a clinical dental examination, these forms were subsequently evaluated by dental students for accuracy. Most differences between form and reality could be traced to the switching of the left and right side of the dentition, and to the misplacing of crowns, or of teeth in the presence of interrupted dental arches. For three patients the differences could not be explained.

In an accompanying letter, the form and its relevance was introduced to the addressed dentate persons. They were asked to fill out the form marking crowns/bridges, extractions, and removable partial or complete dentures. They were instructed to stand in front of a mirror, and describe the mirror image. The possibility of a validation of the self-assessment data afterwards was not mentioned at the time. In Appendix II the form is depicted, with the accompanying instructions translated into English.

Results

A total amount of 968 questionnaires was returned, 29 of those having been returned undelivered because of a change in address, and 3 because of death of the addressed person. Thus, of a total of 936 dentate persons, *i.e.* 72% of the group of possible participants, or 43% of the total group of DNDS dentate persons, longitudinal data of dental and social variables was available. In Table 2.1 the composition of the total group of the DNDS dentate persons is listed by stratification factors: age, sex, region of living, SES, and dental attendance. Also, the percentual response of respondents to the follow-up study relative to the DNDS is given, and the resulting composition of the group of respondents to the follow-up study on the DNDS. In order to check whether the response to the follow-up study had resulted in a selectivity on these variables, participation was analysed by Analysis of Variance (ANOVA. Enter level 0.05; main effects and first order interactions). Analyses revealed the responding group to be older than the non-responding group ($p \leq 0.001$), more frequently belonging to SES-group high ($0.001 < p \leq 0.01$), and being more regular in visiting a dentist for oral check-ups ($0.001 < p \leq 0.01$).

With respect to the form for self-assessment of dental status, 868 persons (93%) had, with the questionnaire, also returned the schematic mouth drawing. In 130 persons from this group, occlusal intraoral photographs of maxilla and mandible were taken at the persons' homes, in order to check for validity of the acquired dental information. These persons were addressed by letter. They were informed as to the relevance of these photographs for obtaining accurate dental information. The results of this validation are discussed separately in paragraph 2.3.2.

Table 2.1 *Composition of dentate respondents to DNDS and to follow-up study by percentages, subdivided on DNDS-stratification factors; percentual response of follow-up study relative to DNDS, subdivided on DNDS-stratification factors*

	SES			Sex		Region				Age		Dental attendance	
	H	M	L	M	F	N	E	S	W	20–44	45–74	R	I
DNDS													
composition	43	20	37	47	53	23	26	27	24	74	26	79	21
Follow-up													
composition	47	20	33	47	53	23	27	27	24	68	32	83	17
% response	47	42	38	43	42	42	45	42	42	39	52	45	35

SES: High/Middle/Low
Sex: Male/Female
Region: North/East/South/West
Dental attendance: Regular/Irregular

Non-response

First, a number of 876 dentate persons was known from earlier correspondence to have lost interest in participating in follow-up studies on the DNDS. To try and find out whether still some response could be anticipated from this group, a questionnaire was mailed to every fifth person: only 24 questionnaires were returned. The remaining persons weigh heavily on the response rate to the follow-up study; a 72% response by the group of 1304 possible participants, *i.e.* upon excluding the non-interested persons, falls to 43% if the total group of 2180 DNDS dentate persons is considered. Secondly, in every location that was visited to make occlusal intraoral photographs of maxilla and mandible in order to check the validity of the self-assessment data, also the persons that had not returned the questionnaire were asked for participation. It was explained to them in a letter that, as a follow-up on the DNDS in which they in 1986 had participated, intraoral photographs would be made. Out of a number of 108 addressed non-respondents to the follow-up study, 52 persons reacted positively to the intraoral photographs; 51 persons could not be reached, because of absence or a change in address. Among those of whom photographs were made at their homes, a questionnaire was left behind to be filled out afterwards. It could be returned in a stamped addressed envelope. Three of those were actually returned.

Since information of possibly important variables, in light of selectivity in (non-)response, for the group of non-respondents to the follow-up study was available from the DNDS (*e.g.*, stratification factors), no further attempt was made to obtain data from this group.

2.3.2 Validity of the self-assessment form

The number of remaining teeth is considered as an indicator of oral health status (Reisine & Bailit, 1980). Clinical and radiological dental examinations can adequately reveal this number, yet at relatively high costs. Questionnaires are frequently used to survey populations about prevailing dental satisfaction, received dental care, and dental attitudes. In a limited number of studies the subject of a self-assessment of the dental status by means of a questionnaire has been addressed. Regarding the presence of removable dentures a good agreement between the self-assessed data and actual dental status was found; but less so with respect to the number of remaining teeth (Helöe, 1972; Könönen *et al.*, 1986; Douglass *et al.*, 1991; Palmqvist *et al.*, 1991). Overall, self-assessment on the presence of removable dentures, and the number of teeth, can be considered a useful method of collecting appropriate population data for screening and planning purposes, at relatively low costs.

In 1986 the first nationwide dental survey among the adult population was carried out in the Netherlands: the DNDS. Aim of the survey was to obtain representative baseline data for the Dutch population, aged 15–74 years of age, concerning the prevalence of oral diseases, the objective and subjective oral health needs, and the oral selfcare (Van 't Hof *et al.*, 1991). In 1992 a follow-up on the DNDS was performed to obtain longitudinal data on these aspects. Since it was not feasible to perform another study as expensive as the DNDS, it was decided to use a written questionnaire. In order to gain insight into the current dental status, and into the changes that had taken place since 1986, a form for the self-assessment of this dental status was used. Extending the area of interest of the studies as reported in the literature (Helöe, 1972; Könönen *et al.*, 1986; Douglass *et al.*, 1991; Palmqvist *et al.*, 1991), people were asked not only to count the number of remaining teeth, but to mark the teeth that had been extracted, crowns/bridges that had been placed, and the presence of removable partial or complete dentures. This was performed by requesting them to fill out a form consisting of a schematic mouth drawing.

The aim of this study was to assess the validity of this method of self-assessment of dental status for each of the variables mentioned: number of remaining teeth, number of crowns/bridges, number of removable dentures, and the accuracy of locating these.

Methods

Together with the questionnaire a special form with a schematic mouth drawing to fill out the current dental status was mailed to the participants of the DNDS known to be dentate in at least one jaw in 1986. These persons were asked to mark the teeth that were absent,

and the crowns and removable dentures that were present. They were instructed to stand in front of a mirror to fill out the drawing as if it were the mirror image. These instructions together with the form, translated into English, are presented in Appendix II. The persons were unaware of validation afterwards.

Of 968 questionnaires returned by addressed dentate persons, 32 were returned undelivered because of a change in address or death; 868 persons (93%) had also filled out the schematic mouth drawing, 7 of which could not be used for validation purposes since they were returned with just the remark that the dental situation had not undergone a change since 1986. A group of 130 people was randomly selected, out of the 861 persons that had filled out the schematic mouth drawing, to validate the acquired data. Of these persons, 30 had complete dentitions. Of the remaining 100 persons with missing teeth, 12 had shortened dental arches only; 88 had (also) interrupted arches. A subdivision was made on stratification factors "age", "sex" and "socioeconomic status" (SES): factors possibly influencing the dental status, as well as the accuracy of scoring.

With the aid of mouth mirrors occlusal intraoral photographs of maxilla and mandible were taken in order to check validity of the self-assessed data. Presence of teeth, of crowns/bridges, and of removable dentures, as well as their respective locations on the schematic mouth drawings, was compared with the data obtained from the intraoral photographs. The photographs were made at the persons' homes with an Olympus OM-2 camera, equipped with Kiron macro lense and Olympus T10 ring flash, at a 0.5x magnification (Kroeze, 1990). Kodak ektachrome EPD 200 color film was used. When wearing a removable denture, photographs were taken of the dentition with and without the denture in place.

When wearing removable partial or complete dentures, only very few persons had actually marked so on the form; the filling out of the form by these persons had been with respect to the teeth that were absent, more than the device that was present. Therefore, when considering the validation of information as obtained with the self-assessment forms, no data can be presented on removable dentures. However, a comparison can be made of the intraoral photographs of these persons with the answers they gave on the questions addressing the subject of presence of removable partial and complete dentures, as obtained with the written questionnaire with which the form was mailed.

Proportions of agreement (P_o) between self-assessed dental status and the intraoral photographs were computed. The number of teeth, of crowns/bridges and of removable dentures, as well as the locations of teeth and crowns were considered. Chi-square testing for statistical significance was used to study the effects of the stratification factors on the results. Furthermore the degrees of over- and underreporting were determined. The third molars were excluded from the analyses, except when explaining for observed differences between the dental status on the self-assessment form and the intraoral photographs.

Results

In Table 2.2 the results of the agreements between self-assessment and intraoral photographs are listed. No significant effects of stratification factors could be noted.

Table 2.2 *Number of remaining teeth, Number of crowns/bridges, Number of removable dentures, and Accuracy of location: agreement, disagreement and explanations for disagreement, by number (n) and percentage (%) of persons*

	Number of remaining teeth		Number of crowns/ bridges		Number of removable dentures		Accuracy of location	
	n	%	n	%	n	%	n	%
	130		52		56		130	
Agreement	**88**	68	**34**	65	**51**	91	**54**	42
Disagreement	**42**	32	**18**	35	**5**	9	**76**	58
under-estimation	14	11	10	19	5	9		
over-estimation	28	22	8	16	–	–		
mirroring							16	12
other explainable mistakes							39	30
unexplainable mistakes							21	16

Number of teeth

Agreement was found in 88 of the 130 persons that were photographed: $P_o = 0.68$. In 30 of these persons complete dentitions were present. Disagreement between self-assessment and intraoral photographs was reflected in an over-reporting of the number of teeth on the self-assessment forms of 59 teeth (2%) in 28 persons; and in an under-reporting of 47 teeth (2%) in 14 persons. Overall, a slight over-reporting (0.5%) of the number of teeth could be found: 2798 teeth were reported by the self-assessment forms, while in reality 2786 were present, as calculated from the intraoral photographs.

Number of crowns/bridges

Agreement between the two modes of examination was found in 34 persons of 52 having crowns: $P_o = 0.65$. Over-reporting on the self-assessment forms was found of 15 crowns (7%) in 8 persons; under-reporting was found of 20 crowns (9%) in 10 persons. Overall, under-reporting of 5 crowns (2%), of an actual number of 230 crowns, was found.

Number of removable dentures

Perfect agreement on the presence of removable partial and complete dentures was found in 48 (P_o = 0.86) out of 56 cases that were present. Three persons said to have a complete denture, while in reality it was a partial one. Thus, overall agreement on the reporting of any removable denture was 51 (P_o = 0.91) out of 56 present: 5 persons said they did not have a removable denture when in reality one was present. No one said to have a removable denture when in reality there was none.

Location of teeth and crowns/bridges

Considering the accuracy of marking the teeth that were absent, and the crowns and bridges that were present on the self-assessment form, perfect agreement was found in 54 persons (P_o = 0.42). In the remaining 76 forms, the self-assessments of 359 places, of which 256 teeth *per se* and 159 crowns, were found to be in disagreement with the intraoral photographs. When excluding from these forms those that contained errors that were due only to the switching of left and right side (mirroring), the number of perfect agreements rose to 70 persons (P_o = 0.54). In 29 of these persons complete dentitions were present.

In the remaining 60 forms some more obvious explanations, besides mirroring, for a total of 299 differences could be deduced by considering the actual dental status, as present on the intraoral photographs. Differences in numbers and/or places of teeth *per se* were found 208 times on the forms of a total of 48 persons; 12 persons exhibited differences only on crowns. In 27 persons 99 misplacings of teeth occurred in the presence of shortened or interrupted dental arches. These persons either did not notice a tooth was missing, or underestimated the number of missing teeth. This irrespective the place of interruption/ shortening in the dental arch. In addition, in 12 persons a total of 22 pontics of fixed bridged were marked as remaining teeth. In 1 person the deviation of the form from the intraoral photographs was due to switching of the markings for extracted and remaining teeth, explaining for 23 teeth wrongly marked as extracted. With respect to crowns/bridges, differences in numbers and/or places were found 135 times with 29 persons. In 8 persons 49 misplacings occurred in the presence of interrupted and shortened dental arches. A number of 16 porcelain-covered crowns was not recognised by 9 persons; a total of 10 pontics of fixed bridges was marked as crowns on the forms of 7 persons. Of 21 persons (16%), a number of 64 disagreements between the self-assessed dental status and the one as obtained by intraoral photographs on teeth *per se*, and 40 on crowns, could not be explained completely.

Discussion

In order to validate self-assessment data, the actual dental data have to be available. To acquire these data, a clinical dental examination may be performed (Helöe, 1972; Douglass *et al.*, 1991; Palmqvist *et al.*, 1991). This would be very time-consuming and expensive. As an approximation of a clinical examination, dental radiographs may be used (Könönen

et al., 1986). It has also been shown that intraoral photographs are well suited to diagnose the number and place of missing and replaced teeth (Arnbjerg, 1988), and even the presence of dental decay as well as the presence and quality of dental restorations (Kroeze, 1990). For reasons of convenience, time and costs, in this study standardised intraoral photographs were used to serve as an objective dental status, for validation of the self-assessed dental data on presence of teeth, crown/bridges and removable dentures, and their respective locations.

Palmqvist *et al.* (1991) report of 100 randomly selected Swedish inhabitants of 45–69 years of age. They asked them to report any removable denture, and the number of teeth present. P_o between self-assessment and succeeding clinical diagnosis with respect to the number of teeth was 0.65. Könönen *et al.* (1986) compared self-assessment data and radiological information of 91 patients of the Psoriasis Centre in Helsinki, and noted a 78% agreement on the number of teeth. Helöe (1972) found in 216 persons, ageing 20-60 years an 83% correspondence in the number of teeth. In 48 community dwelling individuals, aged 70 years or over, Douglass *et al.* (1991) noted underreporting of the actual number of on average 0.4 teeth, as well as a P_o of about 0.50. In our study a $P_o = 0.68$ on the number of teeth was found. These variances are probably reflections of the differences between these studies in the way the persons were questioned about the number of teeth. In the study of Douglass *et al.* (1991) persons were asked about the actual number of teeth present; in our study, persons were asked to indicate where teeth were missing. In the other studies people were asked to count the number of remaining teeth and indicate the correct category, out of 4 to 6 categories with grouped numbers of teeth including "no teeth left" and "all teeth left". By using these limited numbers of alternatives the possibility for miscalculation in the number of teeth is diminished from 28 possible errors to 3 or 5 respectively. Thus, the P_o of our study is to be judged in the light of the way the variable "number of teeth" is measured. As such it supports the applicability of self-assessment data regarding the number of teeth, as mentioned in other studies (Helöe, 1972; Könönen *et al.*, 1986; Douglass *et al.*, 1991; Palmqvist *et al.*, 1991).

With respect to removable dentures, similar results were found as reported in the literature (Helöe, 1972; Könönen *et al.*, 1986; Palmqvist *et al.*, 1991). Information obtained through questionnaires regarding the presence of removable dentures seems valid.

Agreement on the number of crowns/bridges in our study was comparable to the agreement found on the number of teeth. This is somewhat surprising as one might expect to find a less valid result. For instance, it may be difficult for persons not dentally trained to discover porcelain-covered crowns. Also, false-positive or false-negative countings on the number of crowns/bridges may be expected in the presence of posterior teeth with large amalgam fillings. Possibly, the observed level of agreement can be accounted for by the fact that people were asked to mark where crowns/bridges were present. Thereby, they needed to actually look for crowns, more than rely on their memory as to how many had

been placed in the past. When addressing the subject of the number of crowns/bridges in self-assessment data when gathered in this way, the results would seem as applicable as those of the number of teeth.

With respect to locating crowns/bridges and missing teeth, less than half of the persons was able to do so correctly. Despite instructions as to how to interpret the schematic drawing, 15 persons had obviously switched left and right side. This mistake easily can be detected by a comparison with the actual dental status, or by a comparison with a previous dental status in the case of performing a longitudinal study. Besides, mirroring is of little importance when considering overall results, or results per type of tooth, rather than per individual tooth. Of 48 persons (37%) the dental status as obtained would even after a correction for mirroring still yield invalid estimates, of on average 4.3 teeth. This is in accordance with Könönen's *et al.* (1986) results with respect to the distribution of the remaining teeth. When computing their data in the same way as in this study one arrives at an average of 3.1 misplaced teeth.

Another reason for not arriving at the same dental status as on the intraoral photographs was the confusion that arose in scoring the number of teeth that had been extracted. In half of the persons whose forms did not match the actual dental status, this difference could be related to misplacings of teeth due to a counting error in the number of missing teeth in an interruption or shortening of the dental arch. It is deduced that persons either had started counting and marking teeth and crowns from a point in their dental arch that was easily recognised, like an interruption, or by counting from the last tooth present. If, in reality, a different number of teeth were missing in these interruptions and shortenings than was perceived by the participants, miscalculations would occur, either in the number of remaining teeth, and/or in the location of teeth and crowns/bridges. In addition, if extracted teeth had been replaced with dummy teeth, it became even more difficult to accurately count the number of teeth that were missing.

Therefore, the results of this study would implicate that the data of a self-assessed dental status when considering the actual location of teeth and crowns/bridges, are invalid. In the case that no actual dental data, or data from previous investigations are present to compare the self-assessed data with, too many deviations from the actual dental status would be incorporated. Even when it is possible to compare the results with the actual data, as in our study, still a large percentage of disagreement between the sets of data remains without a probable explanation. It would therefore even be very difficult to use appropriate corrections to diminish the bias in results (Palmqvist *et al.*, 1991).

However, when aggregating the data across individuals, the proportions of agreement are such that using of self-assessed dental status can be considered a valuable method in estimating the number of teeth, crowns/bridges and removable dentures present in a population. Additionally, the disagreements were found to be of minor relevance, since the mistakes due to over-reporting and under-reporting averaged, resulting in an accurate reflection of

the total numbers present in the population. As such, self-assessed dental data offer an overview of a population's dental health status, which can be important in the allocation of finances, in dental manpower planning, or the planning of dental health educational programs (Siegal *et al.*, 1988; Van 't Hof *et al.*, 1991; Truin *et al.*, 1992). It may also be used to monitor the effects of such programs, in that over time loss of teeth, or eventually: edentulousness, can be quantified, which is considered to be an indicator of oral health status (Reisine & Bailit, 1980). A self-assessment form could thus easily be integrated into periodic population surveys. The major advantage of using self-assessment of dental status instead of an actual clinical examination would be the extreme savings in expenditures. Apart from the necessary investment in time with clinical examinations, there is no need for dental set-ups, equipment, radiographs, and clinical personnel in the case of self-assessed data-gathering; one sheet of paper and two stamps per addressed person suffice.

2.3.3 Edentulous population

The questionnaire for the edentulous persons addressed person variables, dental attendance, denture wearing behaviour, denture treatments, reasons for treatments, presence of dental implants, and denture satisfaction. In Appendix III the questionnaire is reproduced. The list of DNDS participants that met the criteria for inclusion in the follow-up, held 446 edentulous persons. This number would include those turning out to be lost to follow-up due to unknown changes in address, or due to death.

Results

A total amount of 315 questionnaires was returned, 68 of those having been returned undelivered because of a change in address, and 15 because of death of the addressed person. Thus, for a total of 232 edentulous persons, *i.e.* 64% of possible participants, or 52% of the group of DNDS edentulous persons, longitudinal data of dental and social variables was available. In Table 2.3 the composition of the group of edentulous participants to the DNDS is listed by stratification factors: age, sex, region of living and SES. Also, the percentual response of edentulous respondents to the follow-up study, relative to the DNDS, and the resulting composition of the group of edentulous respondents to the follow-up study, are given. In order to check whether the response to the follow-up study had resulted in a selectivity on these variables ANOVA was used. In the responding group a higher number of persons belonged to younger age groups and higher SES-levels than in the non-responding group. These differences did not hold statistical significance.

Table 2.3 *Composition of edentulous respondents to DNDS and to follow-up study by percentages, subdivided on DNDS-stratification factors; percentual response of follow-up study relative to DNDS, subdivided on DNDS-stratification factors*

	SES			Sex		Region				Age		
	H	M	L	M	F	N	E	S	W	20–44	45–64	≥65
DNDS												
composition	20	18	62	49	51	28	30	24	19	10	50	40
Follow-up												
composition	22	20	58	45	55	30	31	22	17	10	55	35
% response	54	56	48	46	54	54	52	48	46	50	55	45

SES. High/Middle/Low
Sex: Male/Female
Region: North/East/South/West

Non-response

Given the higher average age of the edentulous target group as compared to the dentate, a somewhat lower participation on the questionnaire was anticipated. The reason for this would be, first, a diminishing interest for dental aspects, with a deteriorating general health (Kiyak & Miller, 1982; Branch *et al.*, 1986; Gooch & Berkey, 1987), possibly necessitating the moving to long-term care facilities (Van Poppel & Van der Wijst, 1987; Geurts & Van de Brekel, 1988; Bartlema *et al.*, 1989), and secondly, and ultimately: death. It was found that 26% of the questionnaires that were returned, could not be delivered to the addressed persons anymore. Still, an unexpectedly large proportion of edentulous persons participated in the follow-up study: 64% of 363 possible participants, or 52% of the group of 446 DNDS edentulous persons. No statistically significant differences, between these participants and the non-respondents, were found on DNDS stratification factors. Given the aforementioned, no attempt was made to further improve the participation rate in the study.

2.4 Discussion

The validity of a study is usually separated into two components. The internal validity, which is the validity of inferences for the studied subjects themselves. And the external validity, which is the validity of inferences as they pertain to people outside the study population (Rothman, 1986). Internal validity is a prerequisite for external validity. Specifically,

it implies accurate measurements (Kleinbaum *et al.*, 1982; Rothman, 1986; Bouter & Van Dongen, 1988). Only after having gathered sufficient scientific and theoretical knowledge on (internal) causal relations, *e.g.*, by knowing the variables that may have confounded or modified the effect of the relations, it becomes relevant to investigate the population for which these results would have implications, *i.e.* the generalisation proces (Kleinbaum *et al.*, 1982; Rothman, 1986; Bouter & Van Dongen, 1988). This generalisation requires an understanding of which variables are relevant and which are irrelevant. A relevant variable would thus be a variable that must be mentioned for the generalisation to be valid (Reichenbach, 1965). The knowledge necessary to separate relevant from irrelevant may be absent; this may lead to a purely statistical generalisation of the results, thereby possibly limiting the external validity of the study. To extrapolate results to a larger population, other options besides a purely statistical generalisation, are theoretical knowledge, biological considerations, and the comparison of results with those from similar studies, or with those as found in general (Kleinbaum *et al.*, 1982; Rothman, 1986). Similar results derived from various study groups, with a variety of studied variables, may exclude certain variables as relevant variables to the subject. This would support some external validity of the studies, despite absence of knowledge which variables are relevant.

Internal validity

In our study, internal validity would refer to changes on dental and behavioural aspects since 1986. First, their validity would have to be investigated, *i.e.* the influence of systematic errors, such as selection bias.

Validity

When considering our 1992 dentate and edentulous study groups as part of original DNDS cohorts, non-response leading to selectivity on certain variables, relative to the original cohorts, is of minor importance when presenting merely follow-up data of the study groups, for the follow-up results are compared with 1986-results within the same group of persons. Thus, the presentation of results would be on changes of various aspects over a period of time within a certain group of people: a selection of the original DNDS dentate and edentulous persons. For the same reasons selectivity would be of little importance when searching for explanations for these observed changes. For instance, by using statistical analyses, some significant influences of variables might be revealed, giving possible explanations for the changes as observed in that particular group. As such, in our study dental and behavioural changes since 1986 can be analysed by stratifying them on variables as obtained during the DNDS clinical examination and questionnaires. However, for extrapolation of results from our study group to an actual other population, *e.g.*, the original DNDS cohorts, representativeness of the study group on relevant variables is mandatory since selectivity on these variables *per se* could account for differences in results between study group and original cohort (Rothman, 1986; Bouter & Van Dongen, 1988).

After a period of six years, in 1992 a number of 936 dentate adult Dutch persons participated in the follow-up on the DNDS: 72% of possible participants, and 43% of the DNDS target group. With respect to edentulous persons, 232 participated: 64% of possible participants, and 52% of the DNDS target group. These percentages may seem low response rates when compared with other studies, or even compared with the DNDS itself (*e.g.*, Cutress *et al.*, 1983; Truin *et al.*, 1987; Hand *et al.*, 1988; Hand *et al.*, 1991; Van 't Hof *et al.*, 1991; Kalk *et al.*, 1991). However, when addressing the DNDS group of dentate and edentulous persons no information was present of changes in address, or of deaths, since 1986. Therefore, the actual population that could have been approached for the follow-up must have been smaller than the 2180 dentate and the 446 edentulous persons, thereby in fact increasing our response rates. A suggestion of the influence of this phenomenon can be found in the number of questionnaires that were returned undelivered. Also, when studying the non-response, it was shown that a substantial number of persons not reacting on the questionnaire had moved house since 1986.

Another type of non-response was found in those persons not wanting to react on the questionnaire. Privacy reasons may be a general motive for refusal, besides absence, or illness, or lack of time. With such reasons for non-participation, probably the validity of the study is not jeopardized (Truin *et al.*, 1987; Van 't Hof *et al.*, 1991). A suggestion that such reasons may have been involved in non-response to the questionnaire may be seen in the participation rate on the intraoral photographs of those persons who had not returned the questionnaire itself. Obviously these persons had some reason for not returning the questionnaire, yet they had no objection to participate in another way in the follow-up. It therefore seems that it has not been a general lack of interest that made these persons not respond to the questionnaire.

However, if the non-response did reflect a general disinterest in social and dental aspects, it may have lead to a selectivity of participants, relative to the original DNDS groups, if this disinterest was related to variables that are relevant to the studied aspects. The persons that responded to the questionnaire are then considered to be differing from the non-respondents on such variables. Hereby, the response groups would have become non-representative for the original DNDS groups. As was found in our study, the dentate persons that responded to the questionnaire on average were older persons that more frequently belonged to SES-group high, and were more regular in visiting a dentist for oral check-ups. This could be considered to reflect a better motivated and dental-minded person reacting on the questionnaire. If so, it is unclear to what extent this respondents' selectivity on age, SES, and dental attendance, actually has had implications on our results. Or, in other words, it is unclear if these variables are relevant variables to the studied aspects. In Chapters 3 to 6, the relevance of these and other variables to changes in dental health will be studied.

Precision

The second aspect to the internal validity of a study, is the determination of its precision, *i.e.* the influence of random errors, such as misunderstandings (Kleinbaum *et al.*, 1982).

In our study, a distinction between the 1986 and 1992 questionnaire was present in that the former was an oral one whereas the present was a written one. Asking for answers in the set-up of an oral interview might give rise to "socially desirable" answers, more than when asking the same questions on the basis of anonimity in a written form, especially when addressing attitudes towards health behaviour and received health care (Norheim & Helöe, 1977; Truin *et al.*, 1987; Visser *et al.*, 1989). Also, with time to think it over, a written questionnaire could result in better-considered answers to intricate issues (Norheim & Helöe, 1977). A positive aspect in this light is that the interviewers of the DNDS were not dentally educated. This may have diminished the probability that participants gave socially desirable answers, since there was no reason to fear a personal remark to a specific answer. On the other hand, with the written questionnaire problems may have arisen by confusion over the meaning of questions, which could not be explained by an interviewer. Since the same line of questioning with the written format was used as in 1986, and since the interviewer in 1986 was allowed to only to a certain extent explain a question during the interview, the contribution of such confusion, when present, to a distortion in results between DNDS and follow-up study probably has been of little importance. The equal applicability of oral interview and written questionnaire in obtaining population data is supported by direct comparison of the two methods (Helöe, 1972).

External validity

After having related the changes in dental and behavioural aspects as found in our study group to relevant variables, considering the abovementioned aspects of the internal validity of the study, inferences can be generalised to larger Dutch populations, *i.e.* the external validity of the results can be addressed.

As such, the results of developments in dental health behaviour and dental health status, will be analysed on their external validity, for the generalisation process to national data, in Chapter 7.

CHAPTER

3

Dentate population: Oral self care

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3.1 Introduction

In 1986 the first nationwide dental survey among the adult population in the Netherlands was carried out (DNDS) (Van 't Hof *et al.*, 1991). Aim of the survey was to obtain representative baseline data for the Dutch population, aged 15 to 74 years of age, concerning the prevalence of oral diseases, objective and subjective oral health needs, and oral self care. Individuals ranging from 15 to 74 years of age were selected by non-proportional stratified cluster sampling. Stratification factors were age, sex, region of living, and socioeconomic status (SES); dental attendance was introduced as a post-stratification factor. Various dental aspects have been addressed by the DNDS: periodontal aspects, DMFS-scores, prevalence of mandibular dysfunction, æsthetics, prosthodontic treatments, and treatment needs (Frankenmolen, 1990; Heling, 1990; Kroeze *et al.*, 1990; Burgersdijk *et al.*, 1991a; Burgersdijk *et al.*, 1991b; Kalsbeek *et al.*, 1991; Visser *et al.*, 1991; De Kanter *et al.*, 1992; Karsten *et al.*, 1992). Since hardly any longitudinal data of the Dutch adult population are present on these aspects, the participants were asked for a declaration of no objection to participating in follow-up studies on the DNDS.

It was decided to perform a follow-up on the DNDS in 1992. The main objective of this study was to detect and analyse changes in oral self care, dental attendance and aspects of oral health status among the Dutch adult population, over the period 1986–1992. Since it was not feasible to perform another study as expensive as the DNDS (approximately 1 million US dollars), it was decided to utilise a written questionnaire. This was supplemented with a form for the self-assessment of the dental status, and completed with intraoral photographs. In this paper results of the obtained data concerning oral self care and dental attendance behaviour will be presented.

3.2 Methods

For the present study the dentate persons that participated in the oral interview and the clinical dental examination of 1986 were selected. The edentulous participants of 1986 and the adolescents belonging to the 1986 age group of 15–19 years, the latter because of an expected low response rate, were not included. Thus a total of 2180 persons was available to be approached for the follow-up on the DNDS of which 876 were kwown to have lost interest in participation. Contrary to 1986 when the participants were interviewed during a home visit, in 1992 a written questionnaire was used to obtain information concerning oral self care, dental attendance and dental status from the participants. The same line of questioning was used as in the 1986 interview (Truin *et al.*, 1987).

A total amount of 968 questionnaires were returned in stamped addressed envelopes, 29 of those having been returned undelivered because of a change in address, and 3 because

of death of the addressed person. Thus, of a total of 936 persons, *i.e.* 43% of approachable dentate persons, or 72% upon excluding non-interested persons, longitudinal data of dental and social variables were available over a period of 6 years. For the present study, persons that had become edentulous in both jaws since 1986 (n = 22) were not included.

In order to check for selectivity, participation was analysed by Analysis of Variance (ANOVA. Enter level 0.05; main effects and first order interactions) on age, sex, region of living, SES, and dental attendance. Analyses revealed the responding group to be older than the non-responding group, more frequently belonging to SES-group high, and being more regular in visiting a dentist for oral check-ups. In Table 3.1 these data are listed.

Overall group results were compared with those of 1986. Missing data, due to persons not having answered on all questions in 1986 and/or 1992, occurred between 9 and 64 times. In order to study the changes since 1986 and the influence of stratification factors, stratified analysis (ANOVA) was used. Respondents were classified according to the 1986 information on: age (20–44 years and 45–74 years), sex, SES (high, middle, low), region of living (north, east, south, west), and dental attendance (regular: visiting a dentist for an oral check-up at least once a year; irregular: doing so less than once a year) (Truin *et al.*, 1987). To study the influences of age, period of observation, and time of birth on these changes, Cohort analyses were performed. Departing from the age categories as considered in the DNDS as well as in the first part of this paper, birth cohorts and age categories of 6 succeeding years were formed for these Cohort analyses, to coincide with the period elapsed between the two times of data gathering. Thus, age categories were created of 20–25 years, 26–31 years, 32–37 years, 38–43 years, 44–49 years, 50–55 years, 56–61 years and 62–67 years. The age category 62–67 years was excluded from the analyses, since only 8 persons were present in the 1986 count.

Table 3.1 *Percentages of (non)response by stratification factors*

	age ≥ 45 yrs	SES-high	regular dental attendance
1992: respondents	32%	47%	83%
1992: non–respondents	22%	40%	77%
1986: original group	26%	43%	79%

3.3 Results

ANOVA

Frequency of tooth brushing per day

The results as presented in Table 3.2 show no overall statistical difference between 1986 and 1992. With a corresponding number of persons changing towards higher frequencies of tooth brushing as towards lower, a substantial change in the various frequencies of tooth brushing does not result in a net change in frequency since 1986. Within frequency-groups a trend can be observed with those in 1986 answering to infrequently clean their teeth now claiming to do this on a more regular basis, and with those in 1986 frequently brushing their teeth now tending to do so less frequently. This apparent trend could not be substantiated statistically (p = 0.08). No statistically significant influences of stratification factors were noted.

Table 3.2 *Number and percentage of persons per frequency of tooth brushing in 1986 and in 1992*

	1992									
1986	0		1		2		≥3		1986 totals	
0	7	28%	14	56%	4	16%	–	–	25	3%
1	3	1%	151	66%	67	29%	9	4%	230	26%
2	1	–	85	19%	326	72%	44	9%	456	51%
≥3	–	–	11	6%	66	37%	101	57%	178	20%
1992 totals	11	1%	261	29%	463	52%	154	17%	889	

Use of oral cleaning aids

The percentage of persons reporting to use oral cleaning aids has not changed since 1986: 59% reports the utilisation of at least one oral cleaning aid, compared to 60% in 1986. By analysing the shifts in starting, changing and stopping the use of the various oral cleaning aids, a slight increase in the use of tooth picks could be observed (p = 0.03). No statistically significant influences of stratification factors were present. In Table 3.3 the distribution of the respondents on the use of dental floss and tooth picks in 1986 and 1992 is listed.

With respect to the frequency of using oral cleaning aids no differences with 1986 were present in this group. With respect to dental floss and tooth picks specifically, no

Table 3.3 *Number and percentage of persons per utilisation of dental floss and tooth picks in 1986 and 1992*

1986	1992 floss		tooth picks		both		none		1986 totals	
floss	75	44%	28	17%	24	14%	42	25%	169	19%
tooth picks	7	5%	55	38%	16	11%	67	46%	145	16%
both	27	23%	37	31%	29	24%	26	22%	119	13%
none	60	13%	71	15%	26	6%	315	67%	472	52%
1992 totals	169	19%	191	21%	95	11%	450	50%	905	

Table 3.4 *Number and percentage of persons per frequency of using dental floss and tooth picks in 1986 and 1992*

1986	1992 daily		weekly*		infrequently**		1986 totals	
dental floss								
daily	24	60%	15	38%	1	2%	40	25%
weekly	14	19%	43	58%	17	23%	74	46%
infrequently	7	15%	21	46%	18	39%	46	29%
1992 totals	45	28%	79	49%	36	23%	160	
tooth picks								
daily	28	54%	16	31%	8	15%	52	37%
weekly	13	24%	33	61%	8	15%	54	38%
infrequently	12	34%	16	46%	7	20%	35	25%
1992 totals	53	38%	65	46%	23	16%	141	

* not every day, but at least once a week

** less than once every week

significant shifts in frequency of using by the group could be observed either. In Table 3.4 this subdivision into frequency groups is presented. By stratifying on "age" a statistically significant difference is revealed in the frequency of using tooth picks since 1986 ($p = 0.03$): a 17% increase could be noted in those younger than 45 years of age, whereas older persons showed no change in frequency.

Dental attendance

To investigate whether a change in visits to a dentist had occurred since 1986, two types of visits were distinguished: a visit for an oral check-up, and a visit for treatment of oral complaints.

Considering the period elapsed since the last dental visit for an oral check-up, a highly significant shift towards shorter intervals since 1986 could be noted ($p \leq 0.001$).

Table 3.5 *Number and percentage of persons per period since last oral check-up previous to 1986 and 1992*

1986	1992							
	0–6 months		7–12 months		>1 year		1986 totals	
0–6 months	663	96%	20	3%	9	1%	692	79%
7–12 months	102	86%	10	8%	7	6%	119	14%
>1 year	43	61%	9	13%	18	26%	70	8%
1992 totals	808	92%	39	4%	34	4%	881	

As shows from the results as listed in Table 3.5, of the persons having visited a dentist for an oral check-up within half a year previous to the DNDS, 96% had done so also previous to the 1992 questionnaire. This percentage declines with an increase in the interval since the last oral check-up previous to the DNDS ($p \leq 0.001$): 86% of the persons that had visited a dentist for an oral check-up up till one year previous to the DNDS, and 61% of the persons that had not seen a dentist for an oral check-up within the last year previous to the DNDS. Stratified analysis shows the factor "age" to be of influence on the shift between DNDS and follow-up study towards shorter intervals since the last dental visit for an oral check-up ($p = 0.04$): 15% of those younger than 45 years compared to 18% of those 45 years and over.

As to the number of visits to a dentist because of an oral complaint, a highly significant decrease ($p \leq 0.001$) since 1986 could be noted. In Table 3.6 a subdivision is made of the

persons that previous to the DNDS did visit a dentist because of oral complaints, into those reporting 1 and 2 visits (88% of the visitors), and those reporting more than 2 visits (in 1992, no exact data of the actual number of visits because of oral complaints per person since 1986 were obtained). More dental visits between 1986 and 1992 can be observed in the latter group ($p \leq 0.001$). Stratified analysis reveals the combination of the factors "regularity of dental attendance" and "sex" to be of influence on the number of visits to a dentist because of an oral complaint ($p = 0.03$): in the group of irregular dental attendees 39% of the females and 9% of the males reported less dental visits because of an oral complaint than with the DNDS. In the group of regular dental attendees it was 14% of the females and 16% of the males.

Table 3.6 *Numbers and percentages of persons visiting a dentist because of oral complaints previous to 1986 and 1992*

1986	1992 no visit(s)		1992 visit(s)		1986 totals	
no visit(s)	442	77%	123	23%	545	64%
1–2 visits	216	80%	53	20%	269	32%
≥3 visits	18	50%	18	50%	36	4%
1992 totals	656	77%	194	23%	850	

Cohort-analysis

No significant effects could be noted upon comparing DNDS and follow-up data using Cohort-analyses on the frequency of tooth brushing, and on the utilisation of oral cleaning aids. However, with respect to the number of visits to a dentist, effects of period of observation and/or time of birth (Period-Cohort effect) were observed on dental attendance behaviour for oral check-ups, when considering the new 6-years age categories. In age category 32–37 years a highly significant effect was noted on the fraction of persons having had oral check-ups within half-yearly intervals: $p \leq 0.001$, whereas in the age categories 26–31 years and 56–61 years the p-value was 0.002. In the age categories 38–43 years and 44–49 years the Period-Cohort effect was of a low significance level: $p = 0.02$. In Figures 3.1a&b these data are graphically depicted. By considering the difference in level of dental attendance between 1986 and 1992 (y-axis) per age category (x-axis) in Figure 3.1a, a Period-Cohort effect is visualised. By considering the 1992-level of attendance an

Age-Cohort effect is visualised. In Figure 3.1b the effect of Age and Period is visualised per birth cohort.

With respect to the number of visits to a dentist because of oral complaints, a Period-Cohort effect with a significance of $p \leq 0.001$ could be observed in the age categories 32–37 years, 38–43 years and 56–61 years. In Figures 3.2a&b these data are graphically depicted.

3.4 Discussion

It was shown that persons in 1986 reporting to brush their teeth infrequently, in 1992 report to do so more frequently. Whereas those that in 1986 already brushed their teeth on a frequent basis, in 1992 say to do so less frequently. The statistical phenomenon of "regression to the mean" would, at least in part, explain these observations. Regression to the mean is of special importance in the interpretation of results of continuous variables with inter- and intra-individual variation (Bouter & Van Dongen, 1988), such as in this case the frequency of tooth brushing per day. Given the possible scores, with a DNDS-score of "no tooth brushing at all" a person could not brush less frequently in 1992. Whereas with a DNDS-score of "3 times a day or more" a person could not brush more frequently in 1992. The respondents on these categories could therefore by definition only change in frequency towards the mean scores.

The objective of a Cohort-analysis is to separate the effect of age (Age), period of observation (Period), and time of birth (Cohort) on acquired results (Van 't Hof, 1977; Frencken, 1988). Intrinsic limitation of the analysis is the dependency of each time-related variable, *i.e.* age, period of observation, and time of birth, on the others. Each set of these variables determines the third. An "identification problem" of the actual explaining variable thus evolves: each set of data having at least two etiologic explanations, necessitating the presence of some sort of etiologic concept, or external knowledge, to discuss the outcome (Kleinbaum *et al.*, 1982).

In the case of visits to a dentist for oral check-ups, a Period-Cohort effect was noted. This combination of effects is also known as secular trend: a systematic change in age-specific values over time (Kleinbaum *et al.*, 1982). In this case it means that a shift towards shorter intervals since the last dental visit for an oral check-up can be noted. This may be the result of a specific event or change between or at the two times of data gathering (Period effect), or it may be accounted for by a different time of birth, *i.e.* an intrinsic value for every birth cohort (Cohort effect). By judging the cohort lines, indicating the increase in visiting frequency per birth cohort, the slope of all but the 1925–1930 cohort can be considered more or less similar: effects of age (Age) and period of observation (Period) would be comparable per birth cohort. Not so for the 1925–1930 cohort: it displays a steeper slope,

Figure 3.1a *Age, Period and Cohort effects from 1986 to 1992 on the fraction of persons visiting a dentist for an oral check-up; Age-Cohort and Period-Cohort effects. (Value of each age category depicted at midrange of category. Error bars: Standard Error of Mean (SEM))*

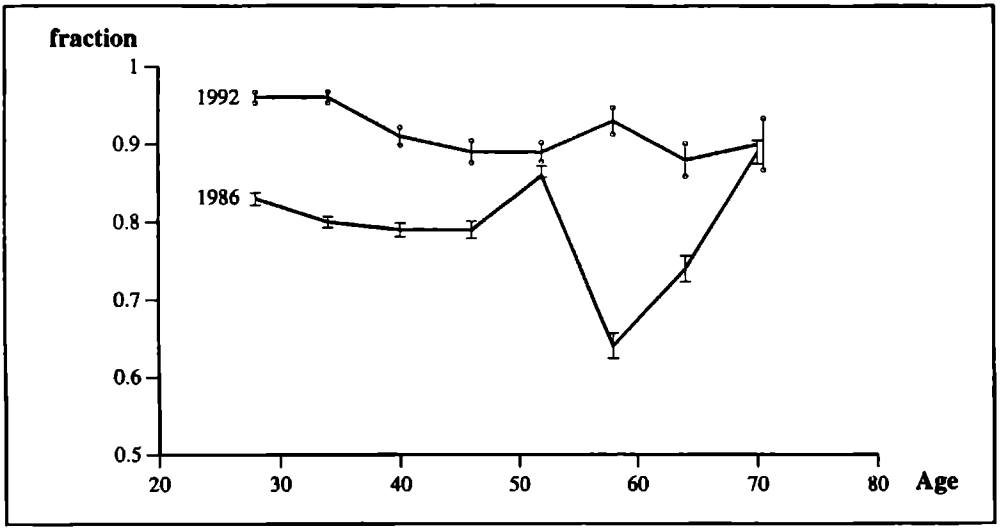


Figure 3.1b *Age, Period and Cohort effects from 1986 to 1992 on the fraction of persons visiting a dentist for an oral check-up; Age-Period effects. (Value of each age category depicted at midrange of category)*

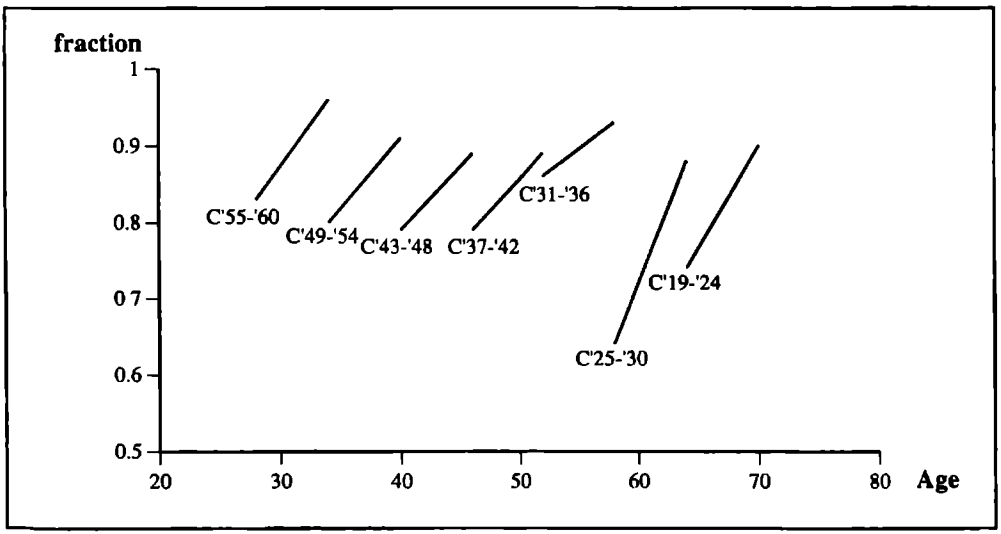


Figure 3.2a *Age, Period and Cohort effects from 1986 to 1992 on the fraction of persons visiting a dentist because of oral complaints; Age-Cohort and Period-Cohort effects. (Value of each age category depicted at midrange of category. Error bars: Standard Error of Mean (SEM))*

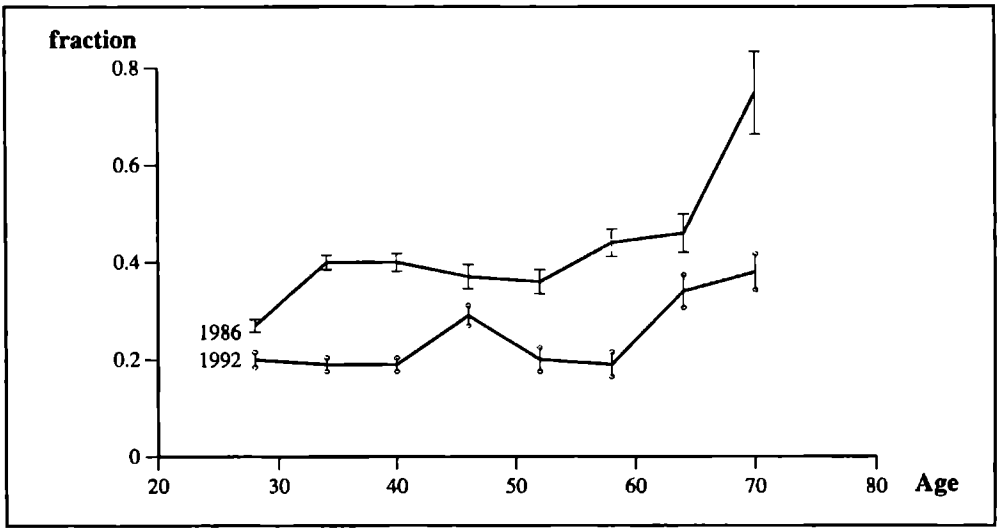
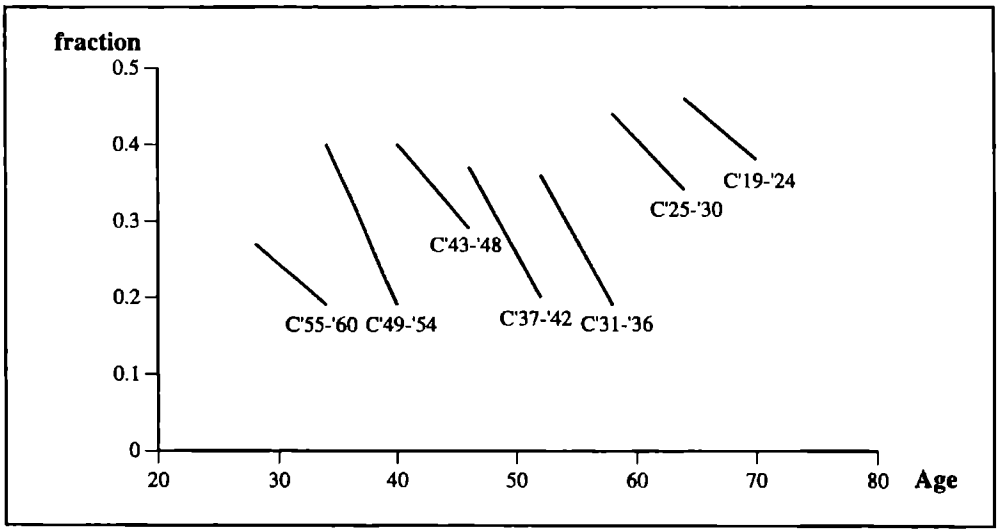


Figure 3.2b *Age, Period and Cohort effects from 1986 to 1992 on the fraction of persons visiting a dentist because of oral complaints; Age-Period effects. (Value of each age category depicted at midrange of category)*



resulting in a leveling of the 1992 curve relative to the 1986 one. Therefore, for the first five age categories the noted Period-Cohort effect could for the greatest part be attributable to the effect of time of measurement: a Period-effect. The underlying phenomenon might be an increase in motivation towards oral health as a resultant of professional attention and of attention on this subject by mass media. This opinion is corroborated by national data, in which an increase in the number of visits to a dentist is present in various age categories (Swinkels, 1993). With respect to the older age categories, this Period-effect is supplemented with a Cohort-effect. Or, alternatively, when considering birth cohorts: Age is of importance besides a Period-effect in the older birth cohorts. Elderly are catching up with respect to the number of visits to a dentist for a check-up. This phenomenon may be considered to be reflected in the postponement of edentulousness to higher age categories (Truin *et al.*, 1992).

With respect to visits to a dentist because of oral complaints, despite the trend being present in all age categories, a statistically significant Period-Cohort effect was present in only three; the number of persons in the other age categories being small. By considering the various birth cohorts, a corresponding Age-Period effect can be noted for each, indicating the importance of the time of measurement (Period-effect) on the acquired results. Probably the increase in the number of visits for oral check-ups is to be considered the complement to the decrease in the number of visits because of oral complaints — a concept that sustains the arguments for the importance of regular oral check-ups.

After a period of six years, in 1992 still a number as large as 936 persons participated in the follow-up on the DNDS, yet with a resulting selectivity on certain stratification factors to the original group. However, this is of little importance when merely presenting the data of changes in oral self care and dental attendance behaviour; either for the group as a whole, or per stratum: for the results are compared with those of the same group of persons as in 1986 — a selection of the original group of 2180 selected dentate persons. Thus, the presentation of results would be on the changes of various aspects with a group of people in a period of time. For the same reasons selectivity is of little importance when searching for explanations for the observed results of this group, *i.e.* the changes in oral self care and dental attendance behaviour. By using stratified analysis, the influence of various variables on the observed changes in this group since 1986 might reveal some significance; in this study the original DNDS stratification factors were used as such. Thus, the presentation of results would be on possible explanations for observed changes in a group of people in a period of time. On the other hand, selectivity could account for deviations in absolute results of the present group from the original group, and from national data, if the selectivity was on relevant variables. However, the changes in behaviour as found in our data were considered to reflect actual changes in the dentate Dutch population, reflecting a general increase in dental health motivation. Since they were also found to be in accordance with national data (Truin *et al.*, 1992; Swinkels, 1993), our results can be considered to reflect a national trend; limiting the distorting effect of selectivity on our results.

CHAPTER

4

Dentate population: Cosmetic dental treatments

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4.1 Introduction

Cosmetic dentistry with non-invasive techniques is a relatively new area of dentistry, in which patients show great interest, despite a possible limited life expectancy of these restorations (Goldstein & Lancaster, 1984). In the Netherlands, about one third of the adult population is dissatisfied with the colour or shape of one or more teeth or restorations in such a way, that they actually want treatment for it (Truin *et al.*, 1988; Truin *et al.*, 1989; Burgersdijk *et al.*, 1991a). The growing importance that is placed on æsthetics may result in a larger demand from the public for cosmetic dental treatment; it may well be that with dentists becoming more familiar with the techniques, an increasing part of the working time of dentists will be spent on cosmetic dental treatments (Truin *et al.*, 1988; Burgersdijk *et al.*, 1991a).

In 1986 the first nationwide dental survey among the adult population in the Netherlands was carried out (DNDS) (Van 't Hof *et al.*, 1991). Aim of the survey was to obtain representative baseline data for the Dutch population, aged 15 to 74 years of age, concerning the prevalence of oral diseases, objective and subjective oral health needs, and oral self care. Individuals ranging from 15 to 74 years of age were selected by non-proportional stratified cluster sampling. Stratification factors were age, sex, region of living, socioeconomic status (SES), and dental attendance (Van 't Hof *et al.*, 1991). Various dental aspects have been addressed by the DNDS (Frankenmolen, 1990; Kroeze *et al.*, 1990; Burgersdijk *et al.*, 1991b; Kalsbeek *et al.*, 1991; Visser *et al.*, 1991; Willemsen *et al.*, 1991; De Kanter *et al.*, 1992; Karsten *et al.*, 1992), including the objective and subjective need for cosmetic dentistry in the Dutch adult population (Truin *et al.*, 1989; Burgersdijk *et al.*, 1991a). The results of the latter study showed a need for cosmetic dentistry in the Netherlands, but it remained unclear to what extent this need would result in an actual demand for cosmetic dental treatment. In Table 4.1, the implications of these results for our study are listed; in 72% of the judgements the examiner and examinee agreed on the æsthetic appearance of the dentition.

In 1992 a follow-up study on the DNDS of 1986 was performed. The main objective was to study changes in oral self care, dental attendance and aspects of oral health status among the Dutch adult population, over the period 1986–1992. Since it was not feasible to perform another study as expensive as the DNDS it was decided to use a written questionnaire. In this paper results of the follow-up study on the DNDS concerning cosmetic dental treatment will be presented.

Table 4.1 *Agreement between objective and subjective cosmetic dental treatment need scores per respondent, as estimated in 1986*

	Subjective				Total	
	Not necessary		Possible/Wanted			
Objective						
Not necessary	415	86%	67	14%	482	52%
Possible/Wanted	196	44%	254	56%	450	48%
Total	611	66%	321	34%	932	

4.2 Methods

For the present study the dentate persons that participated in the oral interview and the clinical dental examination of 1986 were selected. The adolescents belonging to the 1986 age group of 15–19 years were not included because of an expected low response rate. Thus a total of 2180 persons could be approached for the follow-up on the DNDS. Contrary to 1986 when the participants were interviewed during a home visit, in 1992 a written questionnaire was used to obtain information concerning oral self care, dental attendance and dental status from the participants. The same line of questioning was used as in the 1986 interview (Truin *et al.*, 1987). A total amount of 968 questionnaires were returned in stamped addressed envelopes, 29 of those having been returned undelivered because of a change in address, and 3 because of death of the addressed person. Thus, of a total of 936 persons longitudinal data of dental and social variables were available over a period of 6 years.

In order to check for selectivity, participation was analysed by Analysis of Variance (ANOVA. Enter level 0.05; main effects and first order interactions) on DNDS-stratification factors, and on cosmetic dental treatment needs. Analyses revealed the responding group to be older than the non-responding group, more frequently belonging to SES-group high, and being more regular in visiting a dentist for oral check-ups. Also, more frequently an objective cosmetic dental treatment need was present, whereas no effect on the subjective cosmetic dental treatment need was found. In Table 4.2 these data are listed for the respondents to the questionnaires and the DNDS total group.

With respect to cosmetic dental treatments, the persons were asked whether they had been treated with one or more veneers on their anterior teeth, and whether they had one or more amalgam restorations replaced by composite or porcelain restorations. If so, they

were asked to give the respective quantities. Information from 932 respondents could be used. With respect to the persons who had one or more amalgam restorations replaced by composite or porcelain restorations, comparison was limited to those without such replacements but with amalgam restorations present in 1986. Stepwise linear regression analyses (significance level to enter: 0.05; significance level to stay: 0.05) were used to study the influence of DNDS-dental and social variables on the cosmetic dental treatments that had been performed among the respondents. Variables that were included in the analyses consisted of: DNDS-stratification factors; variables indicating financial status; variables reflecting the respondents' oral self care and dental attendance behaviour; variables indicating dental attitudes; clinical dental variables; objective and subjective cosmetic treatment needs. Only variables with statistically significant influence on cosmetic dental treatment will be reported in this paper; they are described and explained in Table 4.3. Listing of these variables is in order of entry into the regression analyses. Risk ratios (RR), or relative risks (Rothman, 1986), were computed to clarify the effect of these variables. Comprehensive descriptions of all variables used can be found elsewhere (Truin *et al.*, 1988; Visser *et al.*, 1988; Burgersdijk *et al.*, 1991a).

Table 4.2 *Percentages of response by stratification factors, and objective cosmetic dental treatment need*

	age ≥ 45 yrs	SES-high	regular dental attendance	objective treatment need
1992: respondents	32%	47%	83%	48%
DNDS: total group	26%	43%	79%	40%

Presentation of results will be divided over two groups: 1. the group of respondents having been treated with veneers, and 2. the group of respondents having amalgam restorations replaced by composite or porcelain restorations. This since in only 24 persons (3% of respondents, and 9% of persons with cosmetic treatments), both of the cosmetic treatments had been performed. Missing data were generated due to persons not having answered all questions in 1986 and/or 1992.

Table 4.3 *Description and interpretation of variables with statistically significant influences on cosmetic dental treatments*

Variable	Levels	Interpretation
Objective need	Present Absent	During DNDS clinical examination one or more anterior teeth and/or restorations were judged by the examining dentist as having deviations in colour and/or shape that were suggestive for, or necessitated, cosmetic dental treatment
Subjective need	Present Absent	During DNDS clinical examination one or more anterior teeth and/or restorations were judged by the examinee as having deviations in colour and/or shape that necessitated cosmetic dental treatment
FS	Less than 25 25 or more	Number of filled tooth surfaces as calculated during DNDS clinical examination
DS	No decay present Decayed tooth surfaces present	Number of decayed tooth surfaces as calculated during DNDS clinical examination
Frequency of toothbrushing	Frequently ≥2 times a day Infrequently <2 times a day	Frequency of daily toothbrushing as estimated in 1986

4.3 Results

Veneers

Of the respondents, 10% (90 persons) reported having been treated with veneers on their anterior teeth. In 74% on up to 2 teeth, in 23% on 3 or 4 teeth. The variables indicating the objective and subjective cosmetic dental treatment need as established during the DNDS clinical dental examination, showed statistically significant influences on having been treated with veneers. These results are presented in Table 4.4.

Among 431 respondents in whom objective cosmetic dental treatment need was present in 1986, 15% (64 persons) reported having been treated with veneers, against 6% among those without objective treatment needs. Among 307 respondents with subjective cosmetic dental treatment needs in 1986, 15% (47 persons) reported having been treated with veneers, against 7% among those without subjective treatment needs. Presence of either "Objective need" or "Subjective need" accounted for 77% (69 persons) of the veneer treatments (RR = 2.9).

Amalgam replacements

Out of 877 respondents with restorations present in 1986, 19% (167 persons) reported to have had one or more of them replaced by composite or porcelain. In 66% in up to 2 teeth, in 29% in 3 or 4 teeth. Four variables were found to have statistically significant influences on having amalgam restorations replaced. These results are presented in Table 4.4. "Subjective need": among 305 respondents with subjective cosmetic dental treatment needs in 1986, 26% (78 persons) reported having amalgam restorations replaced, against 15% among those without subjective treatment needs. "FS": among 481 respondents with more than 25 filled tooth surfaces in 1986, 24% (114 persons) reported having amalgam replacements, against 13% among those with less filled tooth surfaces. "DS": among 443 respondents with one or more decayed tooth surfaces in 1986, 22% (97 persons) reported amalgam replacements, against 16% among those without decayed tooth surfaces in 1986. "Frequency of toothbrushing": of 626 respondents in 1986 frequently cleaning their teeth, 21% (132 persons) reported amalgam replacements, whereas it was 13% amongst the respondents infrequently cleaning their teeth. The presence in premolars and/or molars of secondary decay or of unsatisfactory restorations for other reasons, was not selected in the regression analysis.

Table 4.4 *Effect of selected variables in regression analyses on cosmetic dental treatment, by level of statistical significance (p-value) and relative risks (RR)*

	p-value	RR
Treatments with veneers		
Objective need	0.001	2.6
Subjective need	0.04	2.1
Amalgam replacements		
Subjective need	0.001	1.7
FS	0.004	1.6
DS	0.02	1.4
Frequency of toothbrushing	0.02	1.6

4.4 Discussion

As can be seen from the results of Table 4.1, discrepancy existed among the respondents between cosmetic dental treatment needs as estimated in 1986 by a dentist (objective) and by the respondent (subjective). In 44% of the æsthetic disturbances as judged by a dentist, the respondents themselves did not report an æsthetic problem necessitating some cosmetic dental treatment. Yet, when comparing the influences of objective and subjective æsthetic treatment needs on actually performed treatment, the objective judgement could explain 71% of the veneers that had been made ($p = 0.001$; RR = 2.6), whereas the subjective judgement did so for only 52% ($p = 0.04$; RR = 2.1). If it could thus be said that the subjective opinion has been of less importance in the decision to choose for this æsthetic dental treatment than the dentist', demands for cosmetic dentistry may be derived from objectively estimated treatment needs.

However, according to Burgersdijk *et al.* (1991a), this could lead to an overestimation of demand out of the older age groups. They observed a growing discrepancy between objective and subjective æsthetic treatment needs with increasing age, and suggested a growing acceptance of these situations with age as the possible explanation. In our results, no influence of "Age" could be found on æsthetic treatment. Obviously, the age of the respondents did not hold sufficient statistical significance after "Objective need" and "Subjective need" had been selected in the regression analysis; this would mean that the latter variables could explain better than the respondents' respective ages for having cosmetic dental treatments performed.

We did find however, that the subjective cosmetic treatment need had a statistically significant influence ($p = 0.001$; RR = 1.7) on the replacement of amalgam restorations, whereas the objective treatment need had not. Our results therefore support recommendations on the estimation of treatment demands (Truin *et al.*, 1988; Truin *et al.*, 1989), in that it would be best to incorporate both objective and subjective cosmetic dental treatment needs in order to arrive at the best approximation of the actual demand for this treatment.

As could be expected, disorders in æsthetic appearance showed relevance to the placing of veneers (77% of the veneer treatments). Unexpected might be that 23% of the respondents reported having been treated with veneers that could not be accounted for. It may well be that dental changes since 1986 explain for these remaining 23%. Deviations in colour and shape due to hypoplasia, peg-shaped incisors, or amalgam restorations in mesial, distal or buccal surfaces of anterior teeth, would have been noted in 1986, and would as such have been included in the judgements (Truin *et al.*, 1987; Burgersdijk *et al.*, 1991a). But new discolorations due to non-vitality or restorations, and deformations due to fractured incisal edges, could have occurred in the meantime, necessitating cosmetic dental treatments as judged both objectively and subjectively. An increased awareness of æsthetic values by public and dental profession, and the role theron of the mass media, will no doubt have had an influence as well.

In contrast with the veneer treatments on which the dentists' opinions had more influence than the respondents', the respondents' opinions obviously have had more influence on having amalgam restorations replaced with composite or porcelain than the dentists'. It may be considered more disturbing to have a discoloration due to an amalgam restoration in premolars or molars, than an æsthetic disorder of anterior teeth. As such, the influence of "FS" and "DS" may be explained, in that with increasing numbers of tooth surfaces restored or decayed, the likelihood of an æsthetically disturbing situation increases. One may add a professional side to this, in that a large number of filled tooth surfaces increases the chance for presence of unsatisfactory restorations, or in that dental decay may necessitate the removal of a present restoration; both of which, in light of the æsthetic considerations, may lead to replacement with an æsthetically more acceptable restorative material. However, the presence in premolars and/or molars of secondary decay or the presence of unsatisfactory restorations for other reasons *per se*, were not selected by the regression analysis as variables that could explain for performed cosmetic treatments. It would therefore seem that the respondents' demands to have amalgam restorations replaced have overtaken the importance of dental indications for doing so.

It has been reported (Truin *et al.*, 1988; Truin *et al.*, 1989; Burgersdijk *et al.*, 1991a) that one third of the adult Dutch dentate population is dissatisfied with the colour and shape of one or more teeth or restorations; this discontent is such that they actually want cosmetic dentistry to have the situation treated. In our study, we found 10% of the respondents having been treated with veneers, and 19% having amalgams replaced. When summing the cosmetic dental treatments at person level, this results in 25% (233 persons) of the respondents reporting of æsthetic treatments, *i.e.* an average of 4% yearly. Aesthetic disorders may have been treated otherwise as well, *e.g.*, with crowns and/or bridges. Even so, on a national scale probably a smaller proportion of Dutch adults will actually have had cosmetic dental treatment performed, given the overpresentation of persons with objective cosmetic dental treatment need in our study.

CHAPTER

5

Dentate population: Becoming edentulous

Accepted for publication as: Willemsen WL, De Baat C, Truin GJ, Burgersdijk RCW, Bronkhorst EM. *An investigation into dental and social characteristics of Dutch adults having become edentulous in one or both jaws in a 6-year period.* Gerodontology

5.1 Introduction

According to future scenarios of dental health care (Truin *et al.*, 1992) in the Netherlands the next 25 years will be characterised by a decrease in the number of edentulous persons. The absolute number of edentulous persons is expected to diminish from approximately 2.8 million in 1986 (25%) to about 1.7 million in the year 2020, which would be 12% of the then expected Dutch population of 16 years and over (Central Bureau of Statistics, 1992; Truin *et al.*, 1992). Also, the relative number of edentulous persons in each age group is expected to diminish due to the ageing of dentally healthy young persons, corroborated by an increasing motivation and dental mindedness, as well as an increase in dental attendance of the adult population (Kalk *et al.*, 1989; Truin *et al.*, 1992). These aspects are considered to result in a postponement of the moment of becoming edentulous by approximately 6 years (Kalk *et al.*, 1989; Truin *et al.*, 1992). Despite these declining figures, the absolute number of edentulous persons would still be such that edentulousness would remain a major phenomenon in the Dutch dental future.

In 1986 the first nationwide dental survey among the adult population in the Netherlands (DNDS) was carried out (Truin *et al.*, 1987; Van 't Hof *et al.*, 1991). The aim of the study was to obtain representative baseline data of the Dutch population, aged 15 to 74 years of age, with respect to the prevalence of oral disorders, objective and subjective treatment needs, and oral self care. Individuals ranging from 15 to 74 years of age were selected by non-proportional stratified cluster sampling. Stratification factors were age, sex, region of living, and socioeconomic status (SES); dental attendance was introduced as a post-stratification factor (Van 't Hof *et al.*, 1991). Various dental aspects have been studied from the DNDS (Frankenmolen, 1990; Kroeze *et al.*, 1990; Burgersdijk *et al.*, 1991a; Burgersdijk *et al.*, 1991b; Kalsbeek *et al.*, 1991; De Kanter *et al.*, 1992; Karsten *et al.*, 1992). In 1992 a follow-up of the DNDS was performed. The main objective of this follow-up study was to detect and analyse changes in oral self care, dental attendance and aspects of oral health status among the Dutch adult population, over the period 1986–1992.

This paper will study the dental and social characteristics of the persons having become edentulous in one or both jaws during this 6-year period. As was shown in various studies (Coxhead, 1960; Davis, 1961; Grembowski *et al.*, 1984; Bailit and Braun, 1987; Agerholm and Sidi, 1988; Chauncey *et al.*, 1989), a complex array of factors can lead to the decision to have teeth removed. Clarification of this complexity, to arrive at important variables in describing the change towards the ultimate tooth loss, *i.e.* edentulousness, may be of importance for the success of health promotion efforts aimed at reducing the number of people becoming edentulous.

5.2 Methods

For the present study the dentate persons who participated in the DNDS interview as well as in the clinical dental examination were considered. Persons in 1986 belonging to the age group 15–19 yrs were excluded, because of an expected low response rate as well as an expected small amount of persons actually having become edentulous in one or both jaws since. Those already being edentulous in both jaws in 1986 were excluded as well. Thus, a total of 2180 persons was available to be approached for the follow-up of the DNDS; of these persons, a number of 876 persons was known from earlier correspondence to have lost interest in participating in follow-up studies on the DNDS. Contrary to 1986 when the participants were interviewed during a home visit, a postal questionnaire was used to obtain information concerning oral self care, dental attendance and oral status. The same line of questioning on these issues was used as in the DNDS-interview.

A total amount of 968 questionnaires were returned in stamped addressed envelopes; 29 of these were returned undelivered because of a change in address, and 3 because of death of the addressed person. Thus, follow-up data of dental and social variables over a 6-year period were available of 936 persons (43% of approachable dentate persons; 72% upon excluding non-interested persons). In order to check for selectivity, participation was analysed by Analysis of Variance (ANOVA; enter level 0.05. Main effects and first order interactions) on age, sex, region of living, SES, and dental attendance. No differences were present on sex and region of living. However, the responding group was older than the non-responding group and more frequently belonged to the high SES-group, and was also more regular in visiting a dentist for oral check-ups. In Table 5.1 these data are listed for the responding and non-responding group.

Table 5.1 *Percentages of (non-)response by stratification factors*

	n	age ≥ 45 yrs	SES-high	regular attendance
respondents	936	32%	47%	83%
non-respondents	1244	22%	40%	77%

Clinical dental and social variables, based on studies of Bouma (1987), Van Rossum (1988) and the DNDS (Truin *et al.*, 1987; Truin *et al.*, 1988; Visser *et al.*, 1988), were analysed by

forward stepwise discriminant analysis techniques (significance level to enter: 0.05; significance level to stay: 0.05) in order to detect prognostic variables of becoming edentulous; squared Pearson correlations were computed. The thus selected sets of variables were used in discriminant analyses to compute Pearson correlations with non-selected clinical dental and social variables in order to detect interrelations of variables with the discriminant score, to explain non-entry into the selection and to detect supporting and opposing correlations of the variables with the sets selected. Based on a study by Van Rossum *et al.* (1991a) three groups were considered to distinguish between the various possible changes in dental status. Group 1: persons having changed from a dentate status in maxilla and mandible to wearing complete dentures in maxilla and mandible (n = 9). Group 2: persons having changed from wearing a complete denture in only one jaw to wearing complete dentures in maxilla and mandible (n = 23). Group 3: persons having changed from a dentate status in maxilla and mandible to wearing a complete denture in only one jaw (n = 20). No distinction on the basis of wearing complete dentures or overdentures was made in this study: both are considered to represent an edentulous status.

Finally, the persons who had changed in dental status were contacted and interviewed by telephone. They were asked for the actual reasons for deciding to have their remaining teeth extracted. The questions used were those as used in the study of Bouma (1987). Two persons refused to answer the questions.

5.3 Results

All persons having become edentulous in one or both jaws reported wearing their dentures. A total of 22 persons answered on the written questionnaire not to have teeth of their own anymore. The remaining group of respondents reported to still have (some) remaining teeth in one or both jaws. As shown by the results as listed in Table 5.2, of these dentate respondents 80 persons reported wearing only a complete maxillary denture, 2 persons only a complete mandibular denture, and 10 persons (32 persons with complete dentures in both jaws *minus* the 22 persons who reported to have become edentulous) both, *i.e.* overdentures. A comparison with the 1986 clinical dental data shows that 20 persons report to have become edentulous in the maxilla since 1986, 23 in the mandible, and 9 in both jaws. These changes in dental status since 1986 are listed in Table 5.2 as well.

Forward stepwise discriminant analysis was used to identify a set of variables prognostic of becoming edentulous. The selected variables, as well as the order of entry into the analysis, are listed in Table 5.3.

Table 5.2 *Number of persons per change in dental status since 1986**

1986	1992 Complete maxillary denture	Complete mandibular denture	Complete denture in both jaws	No complete dentures present
Complete maxillary denture	61	–	22	–
Complete mandibular denture	–	1	1	–
No complete dentures present	19	1	9	808

* Missing data on dental status in 14 cases

Based upon the computed squared Pearson correlations, the sets of selected variables could only minimally account for the change in dental status: by raising the Pearson correlation to the square a measure for the discrimination between the groups of persons having become edentulous in one or both jaws and the original groups is created, the explained variance. Thus, in Group 1, only 16% of the variance between the group of persons having become edentulous and the original group, could be accounted for by the selected set of variables. In Group 2 it was 40%, and in Group 3 15%. The variable "number of teeth remaining", *i.e.* the actual number of teeth present as obtained by the 1986 clinical dental examination, was the first variable selected in all three groups. This indicates the relative importance of this variable compared to the others, as is shown by the squared Pearson correlations. Those having become edentulous had less remaining teeth in 1986. With respect to Group 1 the number of decayed surfaces, as obtained by the 1986 clinical dental examination, adds to the change to an edentulous status: more decayed surfaces were present in those persons who have become edentulous. The considered importance of the costs of dental treatment in relation to the treatment obtained is the third variable entering the selection. Those thinking about costs in relation to received treatment were less probable to become edentulous. The last two selected variables: considered importance of dental care, and the frequency of tooth brushing per day, added little to the discriminative capacity of the set of variables. Persons having become edentulous since 1986 gave less value to retaining one's natural teeth, and brushed less frequently than those still having teeth of their own. In Group 2, the period, as expressed in the number of years, that to one's judgment would pass until getting a complete denture is the second variable entering the set. A small period of time until one expects to get a complete denture adds to the probability of change to an edentulous status. This is

followed by "FS", which is the number of filled tooth surfaces, succeeded by the number of deep periodontal pockets, as measured at the DNDS clinical dental examination. The less surfaces filled, and the less periodontal pockets present, the more likely the change to an edentulous jaw had taken place. In the fourth step of the analysis, the variable "number of teeth remaining" was removed from the set of selected variables: after entering "FS" the variable "number of teeth remaining" no longer met the significance level to stay. This indicates an only weak discriminating capacity of the variable at this point in the analysis. The expectation towards receiving a complete denture in future as the person had expressed in 1986, was the last variable to enter the selection: those thinking of receiving a complete denture were more likely to actually receive it. In Group 3, the number of teeth remaining is followed by a compound variable, indicating the knowledge one displays with respect to the negative aspects associated with the wearing of complete dentures. The less knowledge present, the more a person would change to edentulousness. The considered importance of dental care is once again selected, albeit with very little discriminative capacity. As with the regularity of attending a dentist for oral check-ups: regular dental attendees were less likely to become edentulous.

Table 5.3 *Selected variables and order of entry with forward stepwise discriminant analyses (squared Pearson correlations of variables in parentheses)*

Variable	Group 1 *	Group 2 †	Group 3 ‡
Dental attendance			4 (0.01)
Importance of costs of dental treatment	3 (0.03)		
Number of teeth remaining	1 (0.06)	1 (0.19) −4	1 (0.12)
DS	2 (0.05)		
FS		3 (0.07)	
Number of deep periodontal pockets		5 (0.06)	
Frequency of tooth brushing	5 (0.01)		
Considered importance of dental care	4 (0.01)		3 (0.01)
Expectation towards getting complete denture		6 (0.04)	
Expected years until getting complete denture		2 (0.07)	
Knowledge negative aspects complete denture			2 (0.01)
Squared Pearson correlation of set of variables	0.16	0.40	0.15

* Group 1 1986 dentate in maxilla and mandible; 1992: complete dentures in maxilla and mandible

† Group 2 1986 complete denture maxilla or mandible; 1992. complete dentures in maxilla and mandible

‡ Group 3 1986: dentate in maxilla and mandible, 1992: complete denture in maxilla or mandible

In Table 5.4 Pearson correlations of non-selected variables having a statistical significant correlation with the discriminant score of the selected sets of variables are listed. In Group 1 the amount of money one would be willing to spend on dental treatment, and the number of filled tooth surfaces, had a significant correlation with the selected variables discriminating between a dentate and edentulous status. Those having become edentulous since 1986 were willing to spend less money on dental treatment, and had less filled tooth surfaces, than those not having become edentulous. In Group 2, significant correlations could be noted with the number of missing and decayed tooth surfaces: more tooth surfaces were missing, and more surfaces were decayed in those persons having become edentulous since 1986. In Group 3, the number of missing and filled tooth surfaces showed significant correlation with the selected set of variables, as did the variable indicating to what extent a person would add positive aspects to the wearing of a complete denture. In the persons having received a complete denture, more tooth surfaces were missing and less were filled in 1986, than in those not having received it. Also, the former persons attributed more positive aspects to a complete denture than the latter.

Table 5.4 *Statistically significant Pearson correlations of variables with discriminant scores (Positive score: promotes change to edentulous status)*

Variable	Group 1	Group 2	Group 3
Amount of money to be spent on care	−0.71 *		
MS		0.61 **	0.80 ***
DS		0.45 *	
FS	−0.77 *		−0.63 **
Positive aspects of complete denture			0.60 **

* $0.01 < p \leq 0.05$
** $0.001 < p \leq 0.01$
*** $p \leq 0.001$

With respect to the telephone interviews, in the persons having received their first complete denture(s) declining æsthetics was the main reason for extraction (65%). Either because of periodontal problems, *e.g.*, protruding incisors and receding gums, or of cariologic problems, *e.g.*, tooth decay and fractures. In the remainder of cases, recurring dental problems and complaints were the main reasons to ask for tooth extractions. In one quarter of cases, according to the interviewee the dentist had proposed to have the remaining teeth

extracted; because of periodontal problems. In the other cases, it was either the person him/herself or the husband/wife who had proposed to have the remaining teeth extracted. All persons answered to have discussed it at least with their husband/wife; 20% said to have received negative remarks with respect to the proposed wearing of complete dentures. They addressed expected retention problems of the denture. Of 65% of this group the husband/wife and/or many of the relatives and friends were wearing complete denture(s) as well. In the persons now wearing a complete denture in both jaws while already wearing one in 1986, the main reason for extraction was what the respondents considered a bad state of the remaining teeth; which could be translated into cariologic problems. Only 2 spoke of periodontal problems as the main reason for extraction of the last teeth. According to one interviewee the dentist had proposed the extractions; in the remainder of cases it was the person him/herself. Of 91% of this group the husband/wife and/or many of the relatives and friends were wearing complete denture(s) as well.

5.4 Discussion

After a period of six years, in 1992 still a number as large as 936 persons participated in the follow-up on the DNDS, yet with a resulting selectivity on certain variables to the original group. However, this is of little importance when merely presenting the data of changes in dental status; either for the group as a whole, or per stratum: for the results are compared with those of the same group of persons as in 1986 — a selection of the original group of 2180 dentate persons. Thus, the presentation of results is on the changes in dental status in a group of people over a period of time. For the same reasons selectivity is of minor importance when searching for explanations for the observed changes in dental status of this group. The influence of various variables on the observed changes in this group since 1986 might reveal some significance; in this study variables as estimated during the DNDS were used as such. Thus, the presentation of results is on possible explanations for observed changes in a group of people over a period of time. On the other hand, selectivity may be of influence on the results if it had occurred on relevant variables for becoming edentulous: it could then account for deviations in results of the response group from the original group, and from national data. However, our data were found to be in accordance with national data on the incidence of edentulousness (Central Bureau of Statistics, 1992; Truin *et al.*, 1992).

Based on the computed squared Pearson correlations, with the present group of respondents, the available clinical dental and social variables could not characterise risk groups, *i.e.* groups of persons likely to change from a dentate status to an edentulous one in one or both jaws. In other words: given the considered groups no set of variables prognostic of becoming edentulous could be generated. This could be accounted for by the limited

number of persons actually having become edentulous in one or both jaws, relative to the persons not having changed in dental status. Yet, with Group 2 no substantially better set of variables could be found, although a larger number of persons was available for the analysis. No power calculations were applied afterwards to further substantiate this theory, since in order to do so a relation between exposure and disease has to be postulated (Rothman, 1986), *i.e.* a relation between certain variables and edentulousness. With no such relation, as was the case in our study, no effect can be detected since it is unclear what variables should be considered, and how they would influence the change in dental status. Thus, no power calculations could be used to compute the desirable study size, in order to detect a postulated level of effect at a statistically significant level. Secondly, since our data on the incidence of edentulousness were found to be in accordance with national data (Central Bureau of Statistics, 1992; Truin *et al.*, 1992), probably no greater number of new edentulous persons could have been expected to occur in this study population.

No groups were merged in order to raise the number of persons having become edentulous, relative to those not having changed in dental status. Van Rossum *et al.* (1991a) indicated that people with a dentate status in both jaws, and people with a complete denture in both jaws could be characterised as opposite of each other, whereas people with a complete denture in only one jaw could be characterised as an in-between group. Merging of groups in our study would therefore lead to the joining of non-comparable persons on dental and social characteristics. Thus, possible relations between variables and the change in dental status could be obscured. Dissimilarity in the forward stepwise discriminant analysis between these groups on selected variables can be considered to support this assumption.

Another reason for not finding a set of prognostic variables may be that several reasons may prompt a person to ask for a total clearance; they do not necessarily have to be backed up by professional dental opinion and necessity (Bouma *et al.*, 1987a; Bouma *et al.*, 1987b; Bouma *et al.*, 1987c; Visser *et al.*, 1988). By long-standing beliefs and considered reasons persons may attribute positive aspects to (the wearing of) a complete denture; as the variable "Positive aspects of complete denture" indicates. Eventually, this may result in an edentulous jaw, irrespective of the dental condition. It may be that the composition of the present group of respondents, in respect to variables as mentioned, does not allow one to find a set of variables to discriminate between those likely becoming edentulous and those most likely not. The variables and characteristics that would have some influence upon this change are in that case considered to be more homogeneously distributed than in the group of persons not responding on the questionnaire. However, the current level of dental mindedness and dental health education in the Netherlands is of importance in this light. Nowadays even less dentally motivated persons can hardly miss, and hardly avoid being influenced by, the information supplied by dentists and mass media stressing the importance and benefits of retaining one's teeth in a functional status as long as possible. This would influence the natural factors in becoming edentulous, and a leveling would occur.

With the variable "Number of teeth remaining" in the discriminating set of variables, the variables "DS", "MS" and "FS", indicating the number of decayed, missing and filled tooth surfaces respectively, would be expected to have significant correlations with the discriminant score. Perhaps surprisingly the amount of filled tooth surfaces in those having received a complete denture was less, compared to those not having received one. This specific aspect, that at first sight might indicate a better dental health status in those having become edentulous, is a result of the smaller number of remaining teeth, and in fact reflects a worse dental health status. The explanation for the fact that the number of deep periodontal pockets in those not having changed to edentulousness in Group 2 was higher than in the persons that had changed, is probably the same. This aspect of actual dental health status is further shown in the relationship of the DMFS-score of 1986 with the change to edentulousness. The group of persons that had remained dentate since 1986 showed a lower DMFS-score than the group of new edentulous persons.

Considering the work of Bouma (1987), very few if any dental variables were expected to have resulted in the change towards edentulousness. The participants were therefore asked for the actual reasons for deciding to have their remaining teeth extracted. The responses on these telephone interview may be considered to show the importance of the æsthetic value of one's dentition in the decision of having the remaining teeth extracted. Yet, due to the small number of persons having changed in dental status while in 1986 having a compromised æsthetic status, this could not be confirmed by the analyses. The "Aesthetic value of remaining dentition" was a variable constructed from objective ratings by dentists, and subjective rating by participants, in 1986. It may be that both ratings have undergone a change since. An increase in the awareness of æsthetic values may have resulted in a different subjective rating as it would have in 1986. It may also be that the objective value has deteriorated since 1986. Thus, the importance attributed to this variable would be of a different magnitude than as established in 1986. Another factor in the decision of having the remaining teeth extracted would be the recurrence of dental problems. Many of these problems might have been treated dentally, as may be concluded from the small number of cases in which the dentist proposed the extraction of teeth. Yet, a person could have proposed the extractions in agreement with the dentist's opinion. With many of the relatives wearing complete dentures, and the small number of remarks as to expected problems with the wearing of dentures by these relatives, the decision to ask for total clearance to solve these problems would probably not only be an easy one, but for the affected person a logical one as well. Probably more logical than taking a dentist's advice on treating the problem by saving the teeth. As Bouma (1987) concluded, the discrepancies between the dentist's advice and patient's decision can probably be explained by the use of not strictly comparable norms; non-disease reasons and circumstances play a role in the decision-making as well.

CHAPTER

6

Edentulous population: Dental behaviour

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6.1 Introduction

According to future scenarios on dental health care (Truin *et al.*, 1992), in the Netherlands the next 25 years will be characterised by a decrease in the absolute and relative numbers of edentulous Dutch adults. In the period 1988–1990, 24% of the Dutch population 16 years of age and older was edentulous; it is expected that in the year 2020 about 1.7 million persons (ca. 12%) of the Dutch adult population will be edentulous (Central Bureau of Statistics, 1992; Truin *et al.*, 1992). However, it is expected that in future these edentulous older adults will more frequently use dental services than they used to do: an increased dental awareness is thought to likely prompt these persons to visit the dental profession in the case of dissatisfaction with complete dentures (Ettinger & Beck, 1982; Kalk *et al.*, 1992). Thus, despite declining figures of edentulousness, it would remain an important phenomenon in the Dutch dental future.

In 1986 the first nation-wide dental survey among the adult population in the Netherlands (DNDS) was carried out (Truin *et al.*, 1987; Van 't Hof *et al.*, 1991). The aim of the study was to obtain representative baseline data of the Dutch population, 15 to 74 years of age, with respect to the prevalence of oral disorders, objective and subjective treatment needs, and oral self care (Visser *et al.*, 1988; Frankenmolen, 1990; Kroeze *et al.*, 1990; Burgersdijk *et al.*, 1991a; Burgersdijk *et al.*, 1991b; Kalsbeek *et al.*, 1991; Visser *et al.*, 1991; De Kanter *et al.*, 1992; Karsten *et al.*, 1992). Using non proportional stratified cluster sampling, a sample of 6577 persons was contacted, of whom 3526 persons subsequently were interviewed and participated in a clinical dental examination. Stratification factors were age, sex, socio-economic status (SES), and region of living; the degree of urbanisation was proportionally represented in each region. Representative figures were obtained by weighting (Truin *et al.*, 1987; Van 't Hof *et al.*, 1991). With respect to persons wearing complete dentures (Visser *et al.*, 1988), it was found that a minority visited a dentist: 8% dental attendance for denture check-ups, and 22% for visits because of denture problems. On average, the complete dentures were nearly 12 years old, about 20% being older than 20 years. With respect to objective criteria of the complete dentures as measured at the DNDS clinical examination (Truin *et al.*, 1988), 8 to 14% of the complete dentures was found to comply with the formulated quality aspects. In 60% at least half of these aspects was found to be correct. Up to 21% of the maxillary alveolar ridge was found to be severely resorbed, whereas in the mandible it was 75%.

In 1992 a follow-up on the DNDS was performed. The main objective of the follow-up study was to detect and analyse changes over the period 1986–1992 on the aspects as obtained with the DNDS. This paper focuses on Dutch adults wearing complete dentures. The aim of our study was to detect and analyse over the 6-year period changes in dental attendance, denture satisfaction and wearing of complete dentures, and denture treatments.

6.2 Methods

For the present study the Dutch adults wearing complete dentures who participated in the 1986 DNDS-interview and the clinical dental examination were selected: after excluding the persons who were known to have died, a total of 446 persons was eligible for the follow-up on the DNDS. Contrary to 1986 when the participants were interviewed during a home visit, a postal questionnaire was used to obtain information concerning dental attendance, denture satisfaction, wearing of complete dentures, treatment needs, and denture treatments. The same line of questioning on these issues was used as in the 1986-interview (Truin *et al.*, 1987). A total of 315 questionnaires was returned in stamped addressed envelopes, 68 of those having been returned undelivered because of a change in address, and 15 because of death of the addressed person. Thus, of a total of 232 (64% of possible participants) Dutch adults wearing complete dentures, follow-up data of dental and social variables were available over a 6-year period. In Table 6.1 the composition of the group of respondents to the DNDS and to the follow-up study on the DNDS, and the percentual response of respondents to the follow-up study relative to the DNDS, are listed by stratification factors. In order to check whether the response had resulted in a selectivity on relevant variables, Analysis of Variance (ANOVA. On main effects, and on first order interactions between variables; enter level 0.05) was used. No statistically significant differences were found.

Table 6.1 *Composition of edentulous respondents to DNDS and to follow-up study by percentages, subdivided on DNDS-stratification factors; percentual response of follow-up study relative to DNDS, subdivided on DNDS-stratification factors*

	SES			Sex		Region				Age		
	H	M	L	M	F	N	E	S	W	20–44	45–64	≥65
DNDS												
composition	20	18	62	49	51	28	30	24	19	10	50	40
Follow-up												
composition	22	20	58	45	55	30	31	22	17	10	55	35
% response	54	56	48	46	54	54	52	48	46	50	55	45

SES: High/Middle/Low
Sex: Male/Female
Region: North/East/South/West

The group of respondents whose complete dentures had been replaced since 1986 (54 persons), and whose complete dentures had been rebased/relined since 1986 (17 persons), were for statistical reasons merged into one study group ("Denture treatment"). This was done since the interest of our study was in the treatment needs as felt by the respondents, rather than in the technical decision of the dentist to choose for preparing new dentures or merely altering the existing dentures.

To study the changes in attitude since 1986, *i.e.* a shift from one answering level (on the attitudinal variables under study) in 1986 to another in 1992, and to study the influence thereon of DNDS-dental and social variables, ANOVA was applied (Truin *et al.*, 1987; Visser *et al.*, 1988). Considered were: changes in dental attendance (visits *vs.* no visits for denture check-ups previous to the DNDS and between DNDS and follow-up study; visits *vs.* no visits because of denture problems previous to the DNDS and between DNDS and follow-up study), changes in denture satisfaction (satisfied, dissatisfied, neither satisfied nor dissatisfied with complete dentures at DNDS and follow-up) and changes in the wearing of complete dentures (day and night *vs.* only during daytime), and denture treatments. DNDS-dental and social variables used in the analyses comprised person-variables (*e.g.*, SES, sex, age), clinical variables (*e.g.*, quality of complete dentures, levels of alveolar ridge resorption, denture treatments), social variables (*e.g.*, fear for denture problems, denture satisfaction, dental knowledge) and behavioural variables (*e.g.*, dental attendance, denture satisfaction, wearing of complete dentures). A comprehensive description and definition of DNDS-variables is published previously (Truin *et al.*, 1987; Visser *et al.*, 1988). Only variables that showed statistically significant influences on observed changes since 1986 will be addressed. These variables are summarised and explained in Table 6.2.
Risk ratios (RR), or relative risks (Rothman, 1986), were computed to clarify the actual effect of the variables with statistically significant influences on the changes. The original multiple answering levels of "Satisfaction with 1986-complete dentures" were re-grouped into two new levels: "Satisfied" and "Non-satisfied". Analogously, SES-levels "High" and "Middle" were joined.

6.3 Results

In Table 6.3 the variables that were found to have statistically significant influences on one or more of the observed changes since 1986, are listed by their RR's for the various changes. In case of a statistically significant influence of a variable on a change, the level of the p-value is given, and the 95% confidence interval (CI) of the RR.

Dental attendance
With respect to dental visits for denture check-ups a statistically significant shift ($p \leq 0.001$) of 117 respondents, who did not report of a visit previous to the DNDS, towards visits

Table 6.2 *Variables with statistically significant influences on changes since 1986. Levels of these variables, as used for calculating Relative Risks (RR), showing the significant influence of observed changes. Interpretation and explanation of these variables*

Name of variable	Level for RR	Interpretation
SES	Low	Minimum levels of income and education; rating of present profession
Edentulous-period	<20 yrs	Being less than 20 years edentulous in both jaws
Denture age	—	Average age of complete dentures as present in 1986
Number of complete dentures	≥3	Having worn 3 or more complete dentures in both jaws, including complete dentures as present in 1986
Denture border	Correct	No under- or overextension of borders of maxillary and mandibular dentures as measured during DNDS-clinical examination
Denture satisfaction	Non-satisfaction	Respondent's statement on DNDS-questionnaire to be non-satisfied with the present complete dentures
"My dentures need to be treated "	Confirmation	Respondent's statement on DNDS-questionnaire to have the opinion that the present complete dentures need to have some treatment
"I fear my dentures may come loose."	Confirmation	Respondent's statement on DNDS-questionnaire to fear that the present complete dentures might come loose during functioning
Denture treatment	Performed	Constructed variable. having new complete dentures since 1986, or rebasing/relining of complete dentures as present in 1986

between the DNDS and follow-up study, could be noted; only 4 persons reported a shift from visits towards no visits. As shown in Table 6.3, 3 variables showed statistically significant influences on the shift towards dental visits for denture check-ups. "Number of complete dentures": those who had had at least three complete dentures were 1.7 times as likely to have shifted towards denture check-ups than the persons who had worn less complete dentures. When having had denture treatment since 1986, this likelihood was 1.6 times; when having the border extensions of the complete dentures estimated as "correct" during the DNDS-clinical examination, it was 2.0 times.

With respect to dental attendance because of denture problems, a statistically significant shift ($p = 0.01$) of 51 respondents, who did not report of a visit previous to the DNDS, towards dental visits between the DNDS and follow-up study, could be noted; whereas 28 persons had changed to no visits. The mostly reported reasons for these visits were: a lost tooth (30%), a broken denture (18%), lack of retention (18%), and the idea that the dentures were worn (17%). As can be seen from Table 6.3, 2 variables had statistically

significant influences on the shift towards visits because of denture problems: Denture treatment, and SES-Low.

In 1992, 73% of the respondents reported to visit a dentist immediately when having complaints of or problems with their complete dentures; 38 persons reported to have complaints about the complete dentures. The main reason for not having visited a dentist, or dental technician, thus far to solve these denture problems, was in 21% of the cases the idea that nothing could be done.

Denture satisfaction

With regard to denture satisfaction, 62 persons reported differently than in 1986: 34 persons had shifted from non-satisfaction towards denture satisfaction, whereas 28 persons had shifted from denture satisfaction towards non-satisfaction. The main reason for dissatisfaction with the complete dentures in 1992 was an impaired function (76%). As can be seen from Table 6.3, 1 variable showed a statistically significant influence on changes in denture satisfaction: the respondents who in 1986 did consider it necessary to have their complete dentures treated were 2.8 times as likely to show a shift towards denture dissatisfaction, than the persons who did not consider it necessary to have their dentures treated. No statistically significant influence of "Denture treatment" was found on changes in denture satisfaction.

Wearing of complete dentures

All respondents reported that they were wearing their complete dentures; yet 2 persons reported to do so only when having visitors. A statistically significant ($p \leq 0.001$) shift from wearing the dentures day and night previous to the DNDS, towards wearing them currently only during day time, could be observed in 38 persons. In Table 6.3, 3 variables are shown to have statistically significant influences on this shift: DNDS-stratification factor SES-Low; being less than 20 years edentulous during the DNDS; and having expressed the opinion during the DNDS that the complete dentures needed treatment.

Denture treatment

By 71 respondents denture treatments since 1986 were reported. According to 47% of the respondents the reason for treatment was that the dentures were damaged, and in 42% because there was an impaired function or pain. A number of 4 variables showed statistically significant influences on having complete denture treatments: "My dentures need to be treated", and "I fear my dentures may come loose". If at least three complete dentures had been made, the Relative Risk was 2.4 for having complete dentures treated. The persons being non-satisfied with their complete dentures during the DNDS, were 2.6 times as likely for having dentures treated. A statistically significant influence ($0.01 < p \leq 0.05$) of "Denture age" was found: in the persons having had denture treatment the average age of the complete dentures in 1986 was 9.6 years, whereas it was 12.7 years in those without denture treatments. The average denture age of the respondents had increased from

11.9 years in 1986 to 13.9 years in 1992 (average denture age of those with new complete dentures since 1986 was set at 3 years).

Table 6.3 *Variables with statistically significant influences on changes since 1986, by risk ratios (RR). Levels of p-value (p), and the 95% confidence interval of RR (CI) are presented when of statistically significant influence on these changes*

	Changes in									
	dental attendance				denture satisfaction		wearing complete dentures		denture treatment	
	check-ups		denture problems							
Variables	p	RR	p	RR	p	RR	p	RR	p	RR
SES		1.1	*	0.7		1.2	*	1.3		0.8
(CI)				(0.5–1.0)				(1.0–1.7)		
Edentulous period		0.8		0.9		0.8	*	1.7		1.0
(CI)								(1.1–2.5)		
Number of dentures	***	1.7		1.3		1.6		0.5	**	2.4
(CI)		(1.3–2.2)								(1.1–5.1)
Denture border	*	2.0		1.2		0.7		1.4		1.6
(CI)		(1.1–4.0)								
Denture satisfaction		1.1		1.2		–		1.4	**	2.6
(CI)										(1.4–5.0)
"My dentures need to be treated"		1.1		1.2	***	2.8	*	1.6	**	1.9
(CI)						(1.7–4.6)		(1.1–2.3)		(1.3–2.7)
"I fear my dentures may come loose"		1.2		1.5		1.2		0.9	**	2.9
(CI)										(1.6–5.4)
Denture treatment	***	1.6	***	2.8		0.8		1.2		–
(CI)		(1.3–1.8)		(1.6–4.7)						

* $0.01 < p \leq 0.05$
** $0.001 < p \leq 0.01$
*** $p \leq 0.001$

6.4 Discussion

Non-response in follow-up studies may result in a selective response-group, being non-representative for the larger study-group on certain variables. However, when considering such a study-group as a cohort, non-response is of minor importance when presenting follow-up data, for the results are compared within the same group of persons. For the same reasons, selectivity of the respondents is of little importance when searching for explanations for these observed results. Influences of certain variables can be studied and might reveal some statistical significancies. As such, in our study changes in dental attendance, denture satisfaction and wearing of complete dentures, and denture treatment were analysed by stratifying them on variables as obtained during the 1986-clinical examination and questionnaires. An other example can be found in deliberately restricting a study-population on certain variables in order to enhance the internal validity of the study (Rothman, 1986). However, for extrapolation of the results from a selective study group to an actual other population (target population), *e.g.*, generalisation to national data, representativeness on relevant variables is mandatory since selectivity *per se* could account for deviations in results of study-group and target-group (Bouter & Van Dongen, 1988). The composition of our response-group was found to be in accordance with that of the original DNDS-group; no selectivity on relevant variables for the changes under study were found. Therefore, our results can be considered to reflect actual changes among Dutch adults wearing complete dentures.

A distinction between the 1986 and 1992 questionnaire is present in that the former was an oral one whereas the latter was a written one. Asking for answers in the set-up of an oral interview might give rise to "socially desirable" answers, more than when asking the same questions on the basis of anonymity in a written form, especially when addressing attitudes towards health behaviour and received health care (Norheim & Helöe, 1977; Truin *et al.*, 1987; Visser *et al.*, 1989). A positive aspect in this light is that the interviewers of the DNDS were not dentally educated. This may have diminished the probability that participants gave socially desirable answers. On the other hand, a written questionnaire could lead to confusion over the meaning of questions, that can not be explained by an interviewer. Since the same line of questioning with the written format was used as with the oral interview of 1986, and since the interviewer in 1986 was allowed to only to a certain extent explain a question during the interview, the contribution of such confusion probably is of little importance.

Considering the denture treatment that had been performed between 1986 and 1992, as could be expected, variables indicating the level of satisfaction with complete dentures in 1986 and the functioning of these dentures showed relevance. People being non-satisfied with the 1986-complete dentures, people having the opinion that the 1986-complete dentures may come loose during functioning and that they needed treatment, were more than twice

as likely to have complete denture treatment than their counterparts. It has been shown, that it is not so much the objective but rather the subjective treatment need that is decisive in the dental setting (Kiyak & Miller, 1982; Branch *et al.*, 1986; Gooch & Berkey, 1987; Mojon & MacEntee, 1992; Vigild, 1993). This phenomenon is present in our results in that no objective criteria, as obtained in the 1986-clinical examination, of complete dentures and alveolar ridges were shown to have influence on denture treatment, but only respondents' subjective criteria.

Changes in denture satisfaction were related to the imperfection of the complete dentures as considered by the denture wearers themselves. People in 1986 feeling a need for treatment showed a three times increased likelihood of a shift towards dissatisfaction than the persons not considering it necessary to have complete denture treatment. A shift towards denture dissatisfaction might be expected among those thinking it necessary to have their complete dentures treated, were it the case that no actual treatment had been performed to solve the denture problem; or that treatment had not brought the result hoped for. No influence of the variable "Denture treatment" on the changes in denture satisfaction could be observed, while at the same time it was shown (Table 6.3) that the persons in 1986 being non-satisfied with their complete dentures were 2.6 times as likely to have them treated between 1986 and 1992. Thus, one may conclude that denture treatment that had been performed did not result in an overall shift towards denture satisfaction. This is in contrast with results of a study by Vervoorn (1991). She observed that persons wearing complete dentures showed a significantly higher degree of denture satisfaction after treatment with new complete dentures than before. However, our results can be considered to be in line with those of Van Waas (1985). He reported a less than expected number of satisfied patients after treatment with new complete dentures and after one year, despite a variety of alterations to the complete dentures that had been performed.

With respect to dental attendance a significant shift towards visits for denture check-ups could be observed. The respondents must have felt the need to have their complete dentures checked. No correlations were found of variables indicating denture dissatisfaction, or denture problems. However, the variable "Denture treatment" was found to have an RR = 1.6 for the shift towards denture check-ups. The effect of this variable could well be the result of the performed check-up. This could be supportive of the idea that the motivation behind dental attendance is the respondents' concern for their complete dentures. This concern may also be shown in the correct position of the denture borders, and in the higher frequency of receiving new complete dentures: a higher number of complete dentures that had been made previously, while being edentulous for the same period of time as the persons who had not shifted towards visits for denture check-ups. This difference in frequency of receiving complete dentures can be illustrated by the difference in average denture age of complete dentures with *vs.* without treatment. The complete dentures that had been treated since 1986, *i.e.* were rebased/relined or replaced by new, on average showed a younger denture age than those that had not been treated.

As to dental attendance because of denture problems, the shift towards visits was related to a simultaneous denture treatment. Given the cross-sectional way of measuring one cannot be certain about cause and effect, but following common sense and the very reason for dental treatment, it is likely that the change in dentures was the result of the dental visit, rather than the reverse. No influence of the objective status of the complete dentures, as measured during the DNDS-clinical examination, was found to be of influence on the change in visits. Yet when looking at the respondents' reason for these visits, malfunctioning and wearing were reported. As such, this supports results of others (Kalk & De Baat, 1990; Kalk *et al.*, 1991; Vigild, 1993): there is disagreement between patient and dentist with respect to evaluation of the quality of complete dentures. Apart from this disagreement between patient and dentist in their way of estimating treatment need, disparity between dental treatment need and demand rises from the finding that patients not necessarily translate a denture problem into an actual dental visit (Bomberg & Ernst, 1986; Drummond *et al.*, 1988; Vigild, 1993). In our results, this was confirmed as about one quarter of the respondents did not consider it necessary to make a dental visit when having denture problems. Adding to this would be the patients' idea that the complaint is beyond treatment, as reported by 21% of the persons with denture problems.

Our results support the idea that patients' opinions regarding the necessity for regular dental check-ups, and for dental treatments, are more decisive than the dentists' for the actual demand for dental care (Kiyak & Miller, 1982; Branch *et al.*, 1986; Gooch & Berkey, 1987; Mojon & MacEntee, 1992; Vigild, 1993). It was concluded that patients' concerns have given rise to a change in dental attendance and treatments. The observed increase in the number of dental visits, may thus be a reflection of a favourably changing dental awareness of persons wearing complete dentures. Indeed, an increasing demand from the edentulous population for dental health care can be expected (Kalk *et al.*, 1992).

CHAPTER

7

System dynamic simulation: Computer models

7.1 Introduction

Mental integration of knowledge into a coherent and generally accepted theory is very difficult, if not impossible; the structure of the topic under study can be of an intricate pattern, modifying factors may have to be taken into account, and a multidisciplinary approach may be appropriate. One may find that the effects of actions turn out different from, or even opposite to, what was expected (Forrester, 1968). This emphasises the need to organise and integrate all the knowledge relevant to a certain problem, in some other way.

A way of dealing with integration is to use so-called simulation studies. In these studies various types of models are used to simulate and address a specific problem or topic observed in reality. Which specific type of model is most appropriate depends on the problem definition, available time, resources, and available theory and data (Geurts *et al.*, 1989). Often computers are used to calculate the values of various variables and relations, as well as possible future developments of the system the particular model is simulating.

Simulation models offer the possibility to integrate knowledge of various disciplines of science and interests (Truin, 1982; Vennix *et al.*, 1989a). Also, by simulating various modes of action, or by comparing various prime starting points, possible (side-) effects of such measures can be studied by means of scenario analyses (Vennix *et al.*, 1989b; Truin *et al.*, 1992; Bronkhorst *et al.*, 1994). The development of a model greatly contributes to the insight into the variables and parameters most important to the system's behaviour, *i.e.* factors within the part of the society under study that have the most profound consequences when altered (Geurts & Vennix, 1989b; Truin *et al.*, 1992). Furthermore, the explicit formulation of processes having impact on the model's processes may bring to light deficiencies in knowledge regarding the system under consideration. Thus, questions are generated that have to be answered by the people for whom the model is built (Meadows & Robinson, 1985). However, it may be that not all data to serve as input to the model are available. This is a partial explanation for the limited predictive capacity of many models (House, 1982; Meadows, 1982; Vennix *et al.*, 1989b). The other factors being on the one hand the adaptive ability of many systems, *i.e.* the real system may react to output generated by the model, and on the other hand the simplification that is inherent to a model, thereby potentially excluding relevant variables (Truin, 1982). This is not to say that models do not have some predictive capacity, but rather the outcome is to be viewed as a conditional prediction; conditional on various assumptions included in the model (Vennix *et al.*, 1989b; Truin *et al.*, 1992).

7.2 Dutch dental simulation studies

In the late nineteen seventies a research project was initiated at the Department of Cariology and Endodontology of the Dental School of the University of Nijmegen, dealing with the Dutch dental health care system. The project was aimed at surveying and studying the structure and behaviour of this particular health care system, the development of the oral health status of the Dutch population and the interactions with dental health care personnel. This complex system was addressed by means of computer simulation models (Truin, 1982). Since then, two further models with more or less similar structures and characteristics have been developed. System dynamic computer models were used.

7.2.1 System dynamic computer models

System dynamic computer models are based on the opinion that a holistic approach to a specific problem is the relevant approach; the discovering of structures within a system that are causal to the behavioural characteristics and dynamic properties of that system, are considered to be of importance (Forrester, 1961; Vennix *et al.*, 1989b; Vennix, 1990). In system dynamic modeling not only available data and knowledge are used, but also more intuitively determined data: theories and opinions of consulted experts, not necessarily supported by a solid scientific background, may serve as input for the model. Given this vagueness and incompleteness of the input data, these models merely produce forecasts of global qualitative developments at the long term. The prime merit of a system dynamic model would thus be the exploring and explaining of the behaviour of a system (Vennix *et al.*, 1989b).

Perhaps the best known example of the use of a system dynamic computer model is the report of the Club of Rome (Meadows *et al.*, 1974), based upon the outcome of a model addressing future developments in the fields of world-demographics, environmental pollution, and the depletion of natural resources, and dealing with the effects of various options to control these calculated events. Other examples can be found in the fields of geography, power supply, economics, strategic and military services, and for instance the health care system (Klabbers *et al.*, 1989).

A system dynamic computer model consists of three types of variables (Forrester, 1961): input, state and output variables. The input variables are the outcome of processes outside the computer model that have impact on processes within the model. They can be derived by deducing them from the real system or from another model built to describe that part of the real system. State variables compose the internal behaviour of the computer model. It is more or less the memory of the system. State variables are not static expressions, but rather various interactions are possible as variables depend on the value or outcome of others. With the employment of time-dependent variables, time is an integral part of these models. Hence the term: dynamic. By using input variables the state variables will yield results, either used within the model itself or outside the model: output variables.

7.2.2 Dutch dental health care models

- *First model*

The initially developed model was a rather global one, implemented as an interactive computer simulation game, to be played by people from the government and by those working in the field of the dental profession (Klabbers *et al.*, 1980). From within the dental profession, the need was felt to incorporate a greater level of detail to improve the possibility of making decisions in the field of planning oral health care services (Bronkhorst *et al.*, 1990). For instance, the lack of differentiation into age groups, specific pathology and possible treatments was considered too much of an obstruction in effective decision-making. However, the model proved to be a valuable tool in demonstrating problems arising when dealing with complex systems.

- *Second model*

As a result, a second model was developed and implemented in SIMULA on a mainframe computer. It was more detailed than the former one, containing over 300 state variables (Truin, 1982). The model consisted of five submodels dealing with the supply of dentists, with oral pathology (caries and periodontal diseases), with ensuing treatments and with dental attendance behaviour of patients. Six age groups were considered, each in its turn subdivided into people insured by the Dutch National Health Service (NHS. In Dutch: Ziekenfonds; literally translated: Sickfund), and those Privately/not insured. Because of the implementation on a mainframe computer it was difficult to communicate about the results of the model and various scenario runs with people who were interested in it, but who had not been active participants in the development of the model (Bronkhorst *et al.*, 1990). In spite of this drawback, the model and its results were used in a debate on the enrolment capacity of various Dutch dental schools (Truin, 1986; Burgersdijk & Bronkhorst, 1991), and the model has in some way initiated the Dutch National Dental Survey as performed in 1986 (Van 't Hof *et al.*, 1991), by marking white spots in dental epidemiological knowledge.

- *Third model*

Given the demonstrated usefulness of the dental health care computer model, and given the difficulty in communicating about its results, the intricate structure and rigidness in changing specific parameters, it was decided to develop another model (Bronkhorst *et al.*, 1990). Texts addressing this model and its results, are based on reports of Bronkhorst *et al.* (1990) and Truin *et al.* (1992). The third model had to be at least comparable in descriptive qualities to the former one, yet simultaneously eliminating its drawbacks in handling and presentation. Thus, it should offer the opportunity to make fast analyses, preferably generating not only numerical but graphical output as well. In order to end up with a more flexible structure, the use of parameters in the model should be maximised, resulting in the ability to change specific relations or structures when considered necessary, just by changing the parameter's value. Notwithstanding these prerequisites, the model

should be a rather simple one in structure, accessible not only to those having developed it, but also to those who would use and discuss its results and outcome.

Model construction

Following current recommendations the model was built involving the clients it was designed for: dentists, dental hygienists, health economists, and health care planners, originating from the Dutch universities, the Dutch Dental Association, the Dutch Association of Dental Hygienists, the insurance companies, the national government, and the board of the NHS. Besides the positive effect on the model's validity, participative construction also positively affects the client's ability to interpret, and willingness to accept the model's results, especially when not corresponding to personal opinion or expectations (Geurts &Vennix, 1989c; Bronkhorst *et al.*, 1990).

Model structure

The third model is the most elaborate one, containing about 440 state variables and over 4000 parameters. The presentation possibilities were enhanced by incorporating software for reviewing a run's results, and for changing parameters. The model can be divided into three parts: a population model, a supply model and a demand model.

The population model generates demographical data. It contains seven age groups (0–5, 6–12, 13–18, 19–29, 30–44, 45–64 and $\geq$65 years), all of which are divided into two subgroups: people insured by the NHS, and those outside this service, either privately insured or not insured. Each subgroup in its turn is subdivided into people visiting a dentist regularly (*i.e.* people who visit a dentist for oral check-ups at least once a year), people with an irregular dental attendance behaviour, and edentulous people. An outline of this part of the model's structure is given in Figure 7.1.

The supply model generates the total amount of time, in full-time equivalents, that is available for the dental treatment of patients by either dentists or dental hygienists.

The demand model covers the workload for oral health care personnel. It comprises four submodels:

- Visit: dealing with the total number of visits of patients to dentists and dental hygienists;
- Caries and Perio(dontal diseases): two models covering dental pathology;
- Treatments: generating the kind and number of dental treatments provided by dentists and dental hygienists.

The population model is off-line and acts as a driving function for the demand model. The demand model and supply model are dynamically linked; the demand model uses, amongst other variables, the number of available full-time equivalents as calculated in the supply model, while the latter uses the workload for oral health care personnel that has been generated by the treatment model. In Figure 7.2, an overview of the various submodels and their major interactions is given.

For a more comprehensive description of the model and its properties, the reader is referred to Truin *et al.* (1992) and Bronkhorst (1994).

Figure 7.1 *Part of model structure (Source: Bronkhorst et al., 1990)*

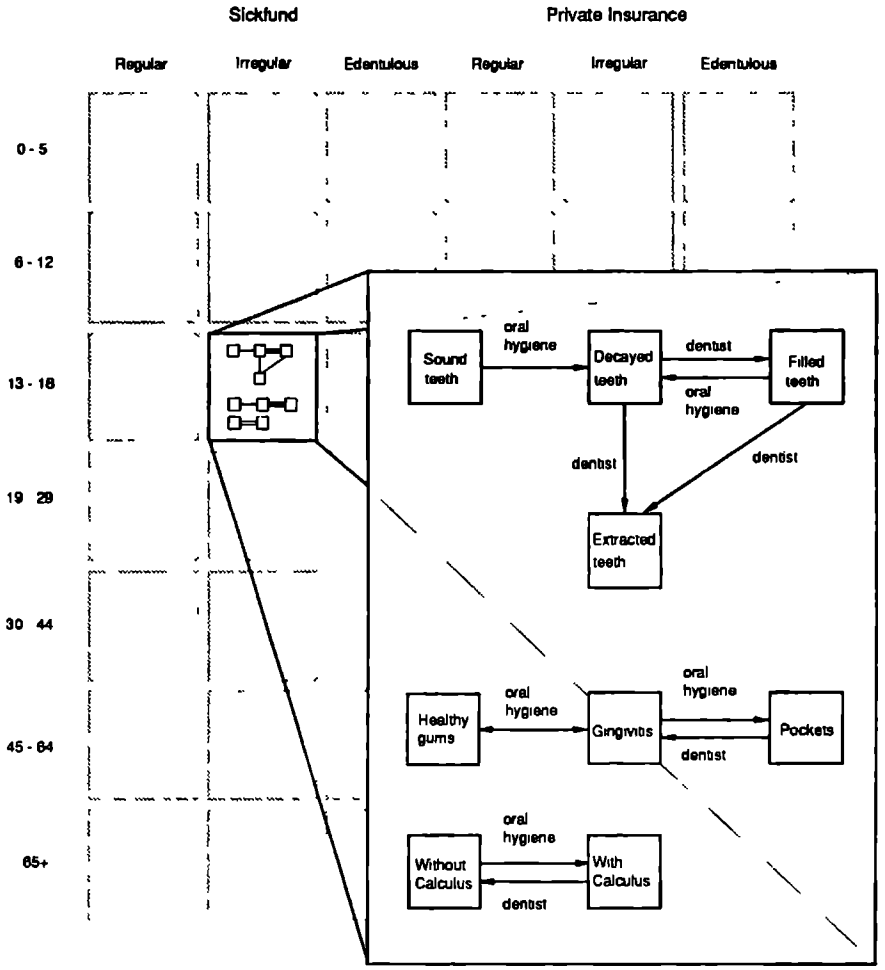
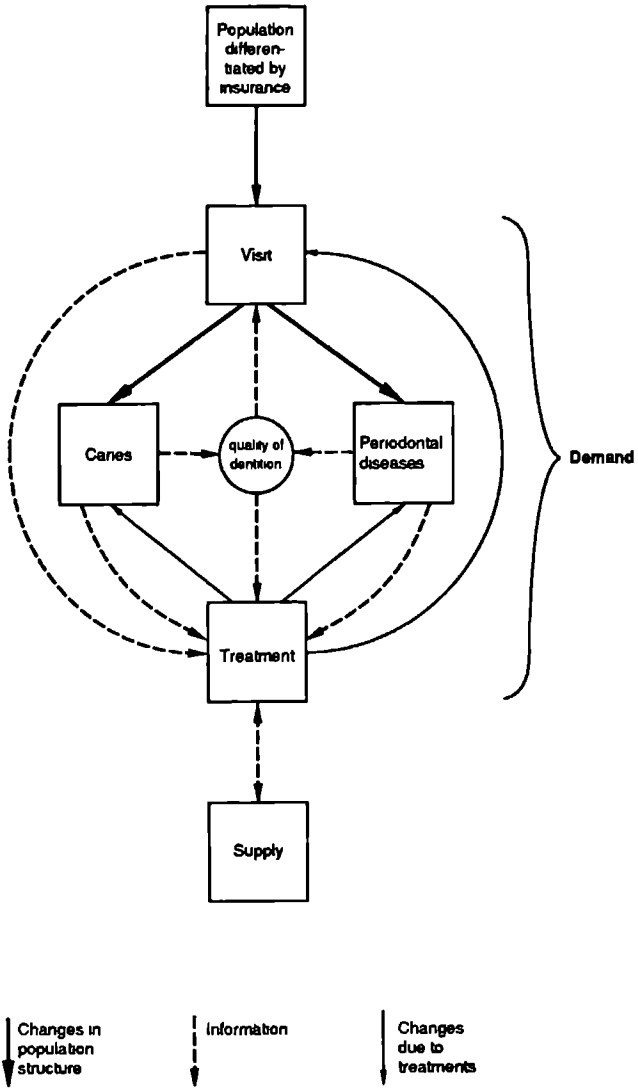


Figure 7.2 *Major interactions between various submodels (Source: Bronkhorst et al., 1990)*



Model results

In 1989 the so-called Steering Committee on Future Health Scenarios (Stuurgroep Toekomstscenario's Gezondheidszorg: STG) decided to subsidise a Scenario Project on dental health care, as formulated at the Department of Cariology and Endodontology of the Dental School of the University of Nijmegen, the Netherlands. The STG was set up by the Ministry of Welfare, Health and Cultural Affairs, with the task to present a picture of future developments in the field of public health and health care. The main objective of the Scenario Project (STG-project) was to provide insight into developments in oral health of the Dutch population over the next 25 years, and into the possible effects and side-effects of considered strategies in facility policies in dental health care and the structure of dental health care (Truin *et al.*, 1992). As such, future scenario's were explored regarding: the incidence of dental caries and periodontal disorders; developments regarding the supply of manpower (and the annual intake of first-year dental and dental hygiene students); the delegation of responsibilities from dentists to dental hygienists; dental practice management and efficiency; and regarding a new system of the National Health Service. Some results of the STG-project (Truin *et al.*, 1992):

- The number of edentulous Dutch people will decrease sharply in the coming decades. The percentage of persons aged 16 years and over, having complete dentures, will drop from about 25% in 1992 to about 12% in the year 2020. As a result, the fraction of dentate persons will grow rapidly: whereas the total Dutch population will expand by 12% in the period 1992–2020, the number of people with a natural dentition will increase by 24%. In particular this growth in the number of dentate persons is responsible for an increase in the demand for dental care.
- Only marginal differences in the prevalence of dental caries and periodontal disorders occurred between the reference scenario on the one hand, and scenarios on increases and decreases in the incidences of these diseases on the other. It was concluded that a sharp rise in the number of people with a natural dentition and the improvement of the average oral health of the dentate Dutch population, can only be marginally affected by additional changes to the current incidences of caries and periodontal disorders. The effects that were shown on the dental care system were limited.
- The future manpower potential of dentists and dental hygienists will be insufficient to meet the demand for dental care. The necessary increase of the two existing Dental Schools' enrolment capacity for both dentists and dental hygienists is calculated to be so large that they will not be able to cope with it.
- The sharp rise in the number of people with a natural dentition, and the manpower needed to meet the future demand for dental health care will lead to a rise in the total cost of dental health care. Nevertheless, in case of a balance between supply and demand, the average costs per person are calculated to remain more or less unchanged.

7.3 Computer simulation in present study

In Chapters 3–6, comparisons were made between the DNDS data of 1986, and those of the follow-up on the DNDS of 1992. Changes in certain aspects of dental health status since 1986 could be detected, whereas others had remained fairly stable. Some of these changes could be considered to reflect changes occurring in larger Dutch population groups than only in the surveyed one, others could be related primarily to the study group.

Since part of the validation of third model, as used in the STG-project, was based on the data as derived from the DNDS of 1986, the data of the follow-up on the DNDS can be used to be either incorporated into the model and as such update the model, or to be the basis for a scenario to calculate possible implications for oral health and oral health care in future. The data that can be considered representative for larger Dutch population groups can be included in the model, whereas scenarios can be based on observations that cannot be generalised beyond the study group.

7.3.1 Results of the questionnaires

Dentate people

Oral self care

As was decribed in Chapter 3, no major differences in the various aspects of oral self care were detected upon comparing the DNDS data with those of the follow-up: the net frequency of tooth brushing had not changed since 1986; a corresponding number of persons having changed towards the higher frequencies as towards the lower. The percentage of persons reporting the use of oral cleaning aids had remained stable, as had the frequency of using them. Therefore, with respect to the computer model, no changes regarding oral self care were applied.

Dental attendance

With respect to dental visits, a highly significant shift towards shorter intervals since the last visit for an oral check-up was reported in Chapter 3, in older persons even more than in younger persons, yet not quite reaching the same total level. As to the number of visits because of oral complaints, a highly significant decrease was noted. This decrease was considered to be the possible complement to an increase in the number of visits for oral check-ups. Since the changes in dental attendance behaviour were considered to be the reflection of a general increase in motivation of dental health, as a resultant of professional and mass media attention, the results of the follow-up were considered to reflect changes in the Dutch population. Secondly, this assumption was supported in that our data were found to be in accordance with similar trends present in national data. As such, the data of the follow-up study regarding dental attendance were incorporated into the computer model.

Cosmetic dental treatments

With regard to cosmetic dental treatments as presented in Chapter 4, 10% of the repondents to the questionnaire reported having been treated with veneers on their anterior teeth. Replacements of existing restorations by composites or porcelains were reported by 19%. When summing the cosmetic dental treatments at person level, this resulted in 25% of the respondents reporting cosmetic treatments, *i.e.* an average of 4% per year. An overrepresentation of persons with objective cosmetic dental treatment need was present in the response-group; this variable proved to be a relevant variable to the performing of cosmetic dental treatments. It was therefore stated that on a national scale probably a smaller proportion of Dutch adults would actually have had cosmetic dental treatment performed in the same period. For this reason, no changes in the model were performed. However, since it is considered likely that these treatments will be more frequently performed in future, and will also have a profound influence on dental health care, it was decided to use the information of the questionnaire as a basis for a scenario on the use of composite. This scenario, as well as the results, will be presented in the next Chapter.

Tooth loss

In the model, a reduction in the number of extractions in future is incorporated. This is reflected in the expected increase in the number of teeth present, and in the increase in the number of dentate persons (Truin *et al.*, 1992). The results of the data obtained with the self-assessment forms revealed that in the respondents 208 teeth had been lost since 1986; a substantial number of persons did not report any loss of teeth. A difference of 30 teeth on a yearly basis is present, when comparing with calculations of the model as used in the STG-project, considering the same number of persons. The differences in the number of extracted teeth may result from a selectivity in response on the self-assessment form. Translating the results of the self-assessment forms to the Dutch population, would result in an improbable extraction pattern. This can be illustrated by presenting the data of regular dental attendees, insured by the NHS; in Table 7.1, these data are listed, together with data as reported by Privately/not insured regular dental attendees. The supposition that a selectivity in response on the self-assessment form is primarily responsible for this deviation in number of extracted teeth, is corroborated by the results of a comparison of the self-assessed data with national reports regarding the same period of time, in people insured by the NHS (Commissie Tandheelkundige Statistiek, 1987–1993): a difference of 47 fewer extractions annually in the self-assessed data was noted, relative to the same number of persons insured by NHS nationally. Therefore, the results of the self-assessment data regarding the number of extracted teeth, were not applied to alter corresponding parameters as present in the model.

Edentulousness

It was reported in Chapter 5 that 32 persons had become edentulous since 1986, being 3% of the study population. Those that had become edentulous in at least one jaw were

52 persons, accounting for 61 jaws, being 6% of the study population. Since the follow-up data on the incidence of edentulousness were found to be in accordance with national data they were considered to reflect those of the Dutch population. As no differences upon comparison with the results as calculated by the computer model were noted, the existing parameters in the computer model, regarding becoming edentulous, were not altered.

Table 7.1 *Self-assessed data regarding the number of extracted teeth since 1986, in regular dental attendees, insured by NHS or Privately/not insured*

Age group	NHS		Privately/not insured	
	Persons	Extractions	Persons	Extractions
19–29 years	129	–	36	–
30–44 years	126	43	70	9
45–64 years	62	–	43	5
≥65 years	10	–	26	29

Edentulous people

Dental behaviour

As presented in Chapter 6, 31% of those who were already edentulous in 1986, reported denture treatments since 1986. It was calculated that the average denture age had increased from 11.9 years in 1986 to 13.9 years in 1992. With respect to dental visits for denture check-ups, as well as to those because of denture problems, a statistically significant shift towards visits could be noted. The composition of our response-group was found to be in accordance with that of the original DNDS-group; no selectivity on relevant variables for the changes under study were found. Therefore, our results can be considered to reflect actual changes in the Dutch population of persons wearing complete dentures. As such, the data as derived from the questionnaires were incorporated into the model.

Overdentures

With respect to the persons having become edentulous in maxilla and/or mandible since 1986 (Chapter 5), 23 persons reported having received overdentures. This was 20% of all respondents wearing complete dentures, and 44% of the respondents who had become edentulous in maxilla and/or mandible. These data were found to be exceeding other Dutch

data: a questionnaire to dentists indicated that one out of every 3 to 4 complete dentures is an overdenture (Van Rossum *et al.*, 1991b); a questionnaire among a number of dental technicians indicated some 10–15% of complete dentures are overdentures (De Baat, 1993). No national Dutch data on the fraction overdentures of complete dentures are available; differences regarding this aspect in the reported studies may possibly be due to a selectivity in response on relevant variables for planning or receiving overdentures. Therefore, no changes were applied to the model, regarding the prevalence of overdentures. However, given current dental education guidelines and the corresponding theoretical rationale, it is expected that the fraction overdentures will increase, at the expense of conventional complete dentures. Secondly, the overdenture treatment *per se* will have a profound influence on dental health care. Therefore, the results of the questionnaire were used as a basis for a scenario on the use of overdentures.

7.3.2 Model input

The following alterations to the model were performed:

Dentate people

Dental attendance

With regard to dental visits for oral check-ups, the results of the questionnaire as presented in Chapter 3 showed that an 18% change since 1986 was present among the respondents over 45 years of age *vs.* 15% among those younger than 45 years. At the same time, among the persons insured by the NHS a 15% increase was present *vs.* 17% among those Privately/not insured. These differences between the subgroups were considered too small given the model's construction and use of variables: no division into subgroups was performed. In Table 7.2, the relevant results regarding changes in dental attendance for oral check-ups, as already presented in Chapter 3, are presented once more.

Table 7.2 *Percentages of persons per period since last dental visit for oral check-ups, previous to 1986 and 1992*

Period since last oral check-up	1986	1992
0–6 months	79	92
7–12 months	14	4
more than 12 months	8	4

The changes can be considered to be the result of the combined effect of people shifting from irregular dental attendance towards regular dental attendance, and of people shifting towards more dental visits. To incorporate this combination of effects into the model, it was assumed (based on results of questionnaire, and validation data of STG-project) that of the persons who had reported of dental attendance for an oral check-up within 6 months previous to the 1992-questionnaire, 90% consisted of regular dental attendees and 10% of irregular dental attendees; visiting frequencies 1.5 and 0.5 times per year, respectively. With respect to the persons who had reported dental attendance between 6 and 12 months previously, the distribution was 70% regular dental attendees and 30% irregular dental attendees; visiting frequencies 1 and 0.4 times per year, respectively. The persons who did not report an oral check-up within the last year, were considered to be irregular dental attendees; visiting frequency 0.25 times per year.

Table 7.3 *Fractions of regular and irregular dental attendees, and annual dental visiting frequency for check-ups in 1986 and 1992, as calculated from the described asssumptions*

	1986	1992
Regular dental attendees		
percentage	80.1	85.6
annual visiting frequency for check-ups	1.44	1.48
Irregular dental attendees		
percentage	19.9	14.4
annual visiting frequency for check-ups	0.38	0.42

In Table 7.3, the results of these calculations are presented. A 5.5% increase in the fraction of regular dental attendees was obtained, together with a supplementary 5.5% decrease in the fraction of irregular dental attendees. The shifts between these complementary groups as already present in the model, were adjusted so as to reach the new fractions by 1992; starting from the beginning of the simulation period, *i.e.* the year 1992. The visiting frequency increased by 0.04 times, among regular dental attendees as well as among irregular dental attendees. These results proved to be not sensitive for variations in the abovementioned assumptions, regarding dental attendance or visiting frequencies.

With regard to dental attendance because of complaints, subdivisions were made into the categories indicating dental attendance behaviour (regular and irregular attendance) and

insurance (NHS and Privately/not insured), as they were observed to influence dental visits because of complaints. Based on the results as presented in Table 3.6, the factors indicating the decrease from 1986 to 1992 in the numbers of these dental visits were: 0.58 for the regular dental attendees, insured by the NHS; 0.88 for the irregular dental attendees, insured by the NHS; 0.75 for the regular dental attendees, Privately/not insured; and 0.28 for the irregular dental attendees, Privately/not insured.

In the model, no subdivision into dental attendance for oral check-ups or complaints is made in dentate adults; the relative distribution of these two types of dental attendance is known only for regular dental attendees. Instead, a net visiting frequency to a dentist per year is used. In order to arrive at a new net visiting frequency on the basis of our data, the ratio between the two types of dental attendance as present in the model, was applied to our data regarding the dental visiting frequencies of regular dental attendees. With respect to the irregular dental attendees, the dental visits were evenly divided between those for oral check-ups and those because of complaints. The fractions indicating the changes in net dental visiting frequency since 1986 thus obtained are presented in Table 7.4. These fractions were applied to the net visiting frequencies as present in the model.

Table 7.4 *Fractions indicating changes in net dental visiting frequency per year of dentate persons*

Group	NHS	Privately/not insured
Regular dental attendees		
19–29 years	0.97	0.99
30–44 years	0.96	0.99
45–64 years	0.95	0.98
≥65 years	0.93	0.97
Irregular dental attendees	0.99	0.69

Edentulous people

Dental attendance

With regard to the various subgroups as used in the model, no differences in dental attendance as reported in Chapter 6 were found large enough to be incorporated into the model. As was shown, on population level, an increase since 1986 was present in both dental

visits for check-ups as well as visits because of problems. These figures were merged, to arrive at the total increase in visiting frequency among edentulous adults. A number of 64 edentulous adults reported during the DNDS having visited a dentist in the preceeding years to 1986, against 200 persons in the same period previous to 1992. This results in a factor of 3.125, describing the change in visiting frequency of edentulous persons.

Average age of complete dentures

In order to calculate the average age of complete dentures per age group in 1992, the increase in denture age of the persons wearing the same complete dentures as present already in 1986, was 6 years; in the persons having received new complete dentures, the average age was arbitrarily set at the midpoint of the time-interval between the two studies, *i.e.* 3 years. In Table 7.5, the thus obtained data regarding the average age of complete dentures are presented. The fractional change in average age of complete dentures since 1986 has been used in the model as multiplication factor for the fraction of complete dentures that are being replaced. The increase in average age of complete dentures does not reach the maximum of 6 years in any age category. A modification has occurred by the new complete dentures that have been placed since 1986.

Table 7.5 *Average age of complete dentures per age category, in follow-up study*

	1986	1992
<45 years	8.0	10.6
45–64 years	12.3	16.1
≥65 years	13.8	13.7

7.3.3 Reference scenario

The results of a model can be described by its reference scenario. A reference scenario is to be seen as a simulation of future developments by excluding unexpected developments. This means that the starting point of the reference scenario is, that every aspect that is thought to determine developments in the field under study will continue to behave in the same way as presently, incorporating present trends in those aspects (Truin *et al.*, 1992). In other words and concerning the present study: a reference scenario simulates future developments of dental health care on the basis of present day information. As such, a reference scenario

can serve as an illustration for the influences of possible future developments: the results from scenario analyses, in which these developments are analysed, can be compared with those from the reference scenario. Thereby, the most probable consequences of the concept, or theory, on which the particular scenario was based, can be shown, and the consequences can be formulated in a more reliable way.

In order to show the consequences of our alterations to the model as used in the STG-project, the results of our reference scenario (new reference scenario) will be compared with those from the reference scenario of the STG-project (Truin *et al.*, 1992).

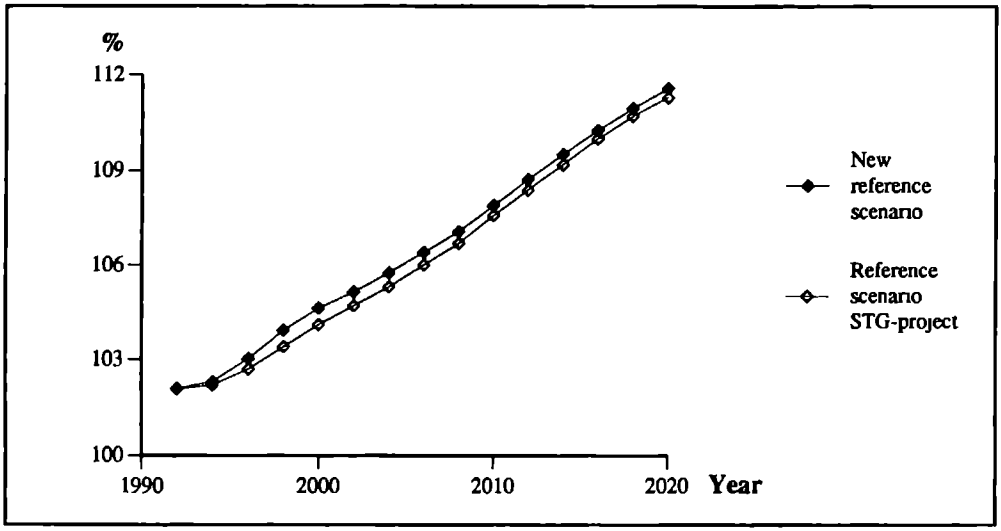
The STG-project revealed that in future, dentists will experience a work overload, expected to amount to more than 11% in the year 2020. Thus, dentists will no longer be able to meet the demand for dental care. In the new reference scenario, this conflict between supply and demand is aggravated by an initial increase of 1%, which levels to a 0.2% increase by the year 2020, accounting for a total of 12% work overload for the dentists. The levelling that occurs can be related to dentists' abilities to adapt practice management to cope with under- or overcapacity. For instance, by longer working hours, a higher average number of treatments per hour, and alterations in the planning of treatments, the surplus demand for dental care may be, partially, met; this will be clarified in the following sections. In Figure 7.3, the phenomenon of increase in the workload of dentists, as calculated in the new reference scenario, is illustrated.

The reference scenario of the STG-project showed that the total number of edentulous persons will fall from about 2.8 million persons in 1992, to 1.7 million in 2020. The percentage of people aged 16 years and over wearing complete dentures, will drop from 25% in 1992 to 12% in the year 2020. Regarding the number of people becoming edentulous, the new reference scenario showed a gradual increase relative to that of the STG-project, eventually mounting to 1%. In the STG-project, the number of people becoming edentulous increased from approximately 26,000 in 1992 to 33,000 by the year 2020, *i.e.* a 27% increase, while in the new reference scenario a 28% increase could be observed. However, the effect of this increase on the total number of edentulous persons in the year 2020 was marginal, due to the only small magnitude of the extra increase, and the large number of persons already being edentulous.

In the STG-project the number of dental visits increased by 21% to approximately 33 million by the year 2020. In the new reference scenario 33.7 million visits were found: in dentate persons the number of visits was slightly less than that in the STG-project, whereas in edentulous persons it had increased from approximately 500,000 to 1.5 million visits.

The STG-project showed that the improvement in the oral health of young people will shift to older age categories. The average number of sound teeth is increasing from approximately 10 sound teeth per person in 1990 to 15 teeth in 2020, while the numbers of missing and filled teeth are at the same time decreasing to approximately 5 missing and 7 filled teeth per person. The number of decayed teeth will remain more or less unaltered at

Figure 7.3 *Utilisation level of dentists* in reference scenario of STG-project, and in new reference scenario*



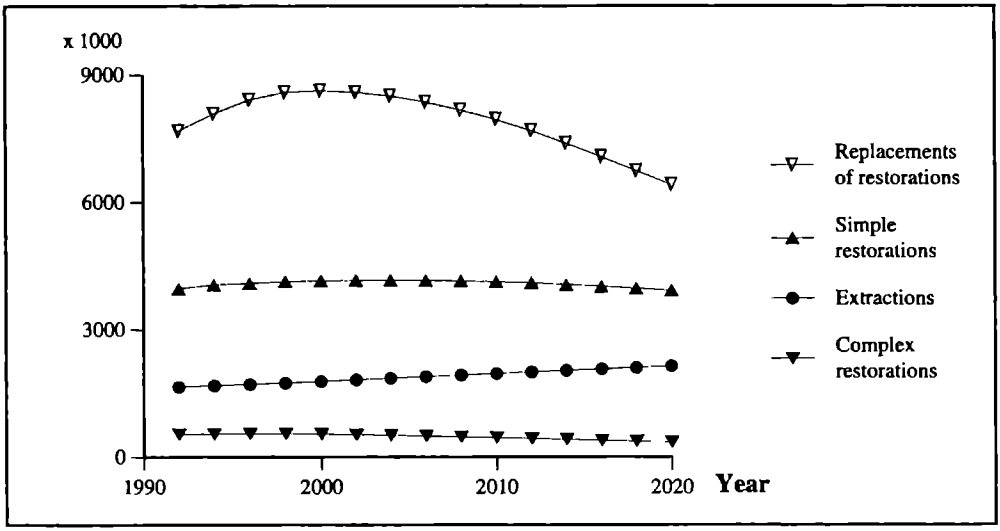
* Utilisation level = 100% represents a perfect balance between supply and demand A utilisation level <100% represents an overcapacity of working time of dentists, *i e* more supply than demand A utilisation level >100% represents an undercapacity of working time of dentists, *i e* more demand than supply

approximately 2 carious teeth per person. With respect to periodontal disorders, the STG-project reported a fairly stable situation for the age categories over 30 years, whereas a fall in the prevalence of periodontal disorders was expected in age category 19–29 years. The new reference scenario showed an unaltered situation regarding dental caries: no changes could be noted in the number of sound, decayed, filled and missing teeth. The same holds true for periodontal disorders.

With respect to the ensuing dental treatments, the number of extractions was calculated by the STG-project to increase from approximately 1.5 million in 1992 to 2.1 million by the year 2020. The new reference scenario showed a very small decline initially, after which the number of extractions steadily increased to a final 1% more by the year 2020, relative to the development as forecasted by the STG-project. In the new reference scenario the number of simple dental restorations remained unaltered; regarding the number of replacements of existing restorations, and the number of complex restorations, an initial

1.5% increase relative to the development in the STG-project could be noted, which levelled at a 1% increase by the year 2020. The effect of these differences, between the results of the new reference scenario and those of the reference scenario of the STG-project, on the calculated developments in the number of extractions and restorative treatments, are graphically presented in Figure 7.4.

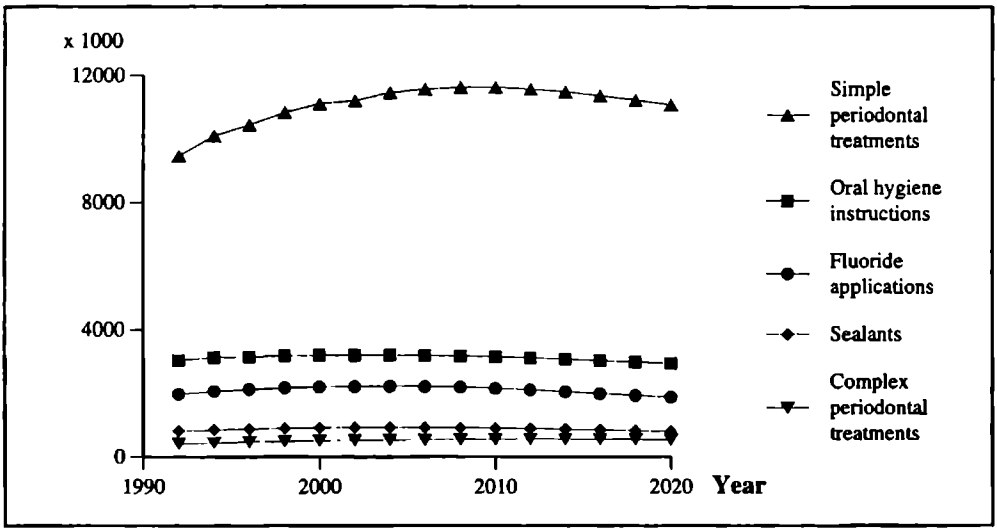
Figure 7.4 *New reference scenario: number of extractions and restorative treatments in Dutch adult population*



The STG-project reported an increase in the number of simple periodontal treatments of approximately 9 million treatments in 1992 to 11 million by the year 2020; this remained unaltered in the new reference scenario. With respect to the number of complex periodontal treatments, an initial 1.5% higher increase in the new reference scenario than in the STG-project gradually increased to 2.5%: from approximately 400,000 treatments in 1992 to 550,000 by the year 2020. The effects on the total number of periodontal treatments in the new reference scenario are presented in Figure 7.5. No differences were noticable between the two reference scenarios regarding preventive treatments.

In the new reference scenario, the number of treatments with partial dentures remained unchanged relative to that of the reference scenario of the STG-project. The number of new complete dentures in the new reference scenario showed a gradual increase to end at 1% more than the increase in the STG-project. With respect to the number of replacements

Figure 7.5 *New reference scenario: number of preventive and periodontal treatments in Dutch adult population*



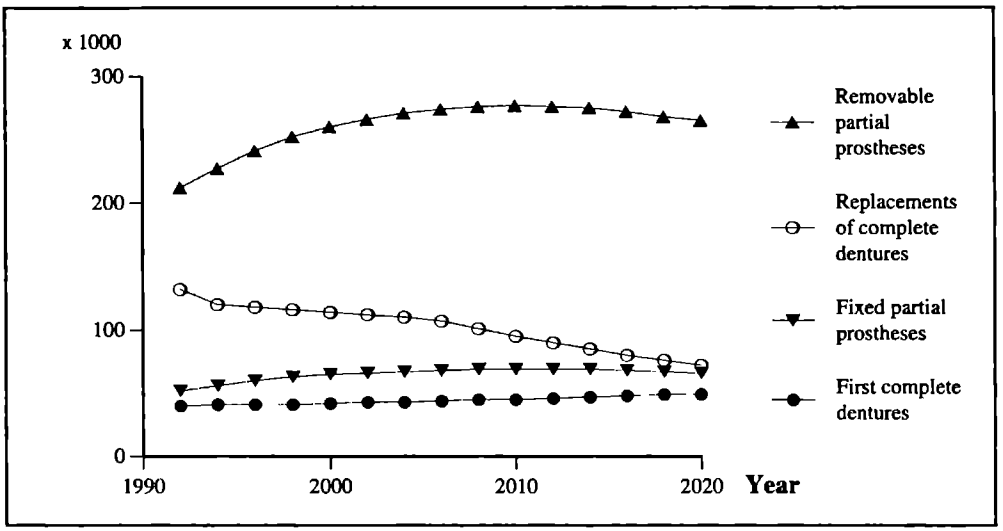
of existing complete dentures, the STG-project reported a decrease from approximately 138,000 in 1992 to 75,000 by the year 2020. In the new reference scenario, the number of replacements of complete dentures was sharply diminished by 8% initially, after which it gradually rose again to level at 3% below the development in the STG-project by the year 2020, due to the change in average age of complete dentures in the new reference scenario. From approximately 180,000 treatments with complete dentures by the start of the new reference scenario, it declined to 120,000 by the year 2020. In Figure 7.6, the effects on the total number of denture treatments in the new reference scenario are graphically presented.

The annual total cost of dentistry, excluding specialists' treatments, remained unchanged, relative to the STG-project: from approximately 2075 million Dutch guilders at the start of the reference scenario, it increased to 2200 million by the year 2020.

7.3.4 Conclusion

Generally, our alterations to the model resulted in small differences of the new reference scenario, compared to that as generated before the alterations, *i.e.* from the model as used

Figure 7.6 *New reference scenario: number of dental treatments with partial and complete dentures in Dutch adult population*



in the STG-project. However, a slight deterioration of oral health status was observed, in a small increase in the percentage of new edentulous persons in the new reference scenario, relative to the STG-project. Also, an increase in the number of extractions can be observed.

An initial increase in the number of restorative and periodontal treatments was observed. This increase in the number of time-consuming treatments, probably due to an increase in the number of regular dental attendees in whom these treatments are mostly being performed, results in an initial increase in the work overload that is being experienced by the dentists. This conflict between supply and demand is crucial in explaining the effects that occur after this initial stage. In order to cope with the demand for dental care, a change in dental treatments is taking place: the number of extractions is increasing, at the expense of the number of restorative and periodontal treatments. The number of new edentulous persons increases, accompanied by an increasing number of new complete dentures. Eventually, the capacity utilisation of dental practices in the new reference scenario levels at slightly above that of the STG-project (0.2%).

7.4 Discussion

Not necessarily do these forecasts become reality. It may well be that the developments are modified, for instance if the Dutch government decides to finance a third Dental School, thus influencing the overall enrolment capacity for dental students and dental hygienists, and eventually influencing the capacity utilisation of dental practices. A balance between the demand for and supply of dental care would be achieved, according to the STG-project, if the enrolment capacity was raised from 180 to 360 dental students per year (Truin *et al.*, 1992).

Another factor that could influence the results regarding oral health care, is the possibility that dentists close their practices for new patients or certain treatments, if too great a discrepancy between demand and supply arises. This could mean for instance, that the fraction of irregular dental attendees would rise, accompanied by a deterioration of oral health status. Also, the number of extracted teeth may increase, which may slow down the fall in the number of edentulous persons. These factors can be observed to occur to some extent in the new reference scenario. Dentist may also choose to delegate some of their work to other dental personnel, *e.g.*, dental hygienists.

Other, unpredictable, phenomena that may have considerable influence on dental health or dental health care may further remove the model's results from future's reality. But, as explained before: even if it is thus impossible to accurately predict the future dental health status, still the model provides valuable insight into the processes that influence developments in this health status. In the next Chapter, the influence of two such phenomena is studied by means of scenario analyses.

CHAPTER

8

System dynamic simulation: Scenario analysis

8.1 Introduction

Scenario analyses are used to analyse the behaviour of a model under different conditions, or under the influence of different policy options. Thus, the effect of certain options on future developments can be observed, on the basis of the estimated future course of these variables. The aim of scenario analyses is to acquire a better insight in the dynamics of the system under study or, in other words, to acquire a better insight in the possible effects of different policy alternatives on the behaviour of the entire system, and in the explanation of these effects. These effects may be different from the consequences that were expected on the basis of the (partial) overview of the particular system.

The term "scenario" is used to denote a selection of variables that are to play a role in this particular use of a model. This selection has to be based on a central idea that binds the variables together, and lends coherence to the scenario. Two types of scenarios can be distinguished: prospective and projective scenarios. Prospective scenarios are used to explore the future of the simulated system, whereas projective scenarios aim at deciding which measures are necessary in order to arrive at a specified situation at a certain moment in future. In the present study, we will use prospective scenarios, as in the STG-project.

The input to the model, *i.e.* the data of the particular scenario, is not necessarily of great importance: it may contain a number of selections unlikely ever to become reality. In other words: not necessarily does the input have to be selected so as to reflect developments that are expected to actually happen. Because it is when the results of a scenario are considered in relation to the selected input that a scenario becomes fruitful. When used in this way, the gathered knowledge may lead to a better decision making, since the behaviour of a system on a decision is explored, rather than that only the effects of that decision are being calculated.

8.2 Scenarios on the use of composite

The growing importance that is put on personal appearance in modern society, will probably result in an increasing demand for cosmetic dental treatments (Truin *et al.*, 1988; Burgersdijk *et al.*, 1991a). The use of æsthetically acceptable materials does not have to be limited to anterior teeth; in the posterior oral segment treatments are shifting from using amalgam to composite (Erickson, 1985). Discussions on the supposed detrimental systemic effects of amalgam will probably have influenced this shift as well. A positive influence of the use of composite in restoring carious lesions also in the posterior oral segment, exists on the preservation of tooth structure (Fukushima *et al.*, 1988); but it will also very likely increase the workload of dentists, since the treatment times are estimated to be higher than for amalgam restorations (Dilley *et al.*, 1990; Kreulen, 1992). As a consequence, the fees for

composite restorations are higher than for similar amalgam restorations (Commissie Tandheelkundige Statistiek, 1992; Nederlandse Maatschappij tot bevordering der Tandheelkunde, 1992). The relative life-expectancy of composite restorations, as compared to amalgam, is as yet uncertain. Clinical experience with amalgam has been much more extensive, and the composition of composites has changed dramatically over the years, as has the indication for using composite (Simonsen, 1978; Lutz *et al.*, 1985; Hunt, 1990). However, some aspects that have negatively influenced the longevity of composite in the past, *e.g.*, wear and marginal adaptation, have been favourably changed over time to become of less clinical relevance (Roulet, 1988; Sturdevant *et al.*, 1988; Wilder *et al.*, 1991).

In order to investigate the implications of an expanding use of composite, scenarios were formulated with as central theme: "a complete acceptance by dental profession, insurance companies and patients, of composite as restorative material".

8.2.1 Model input

Dental indication

Following the clinical use of Preventive Resin Restorations, in the scenario all new carious lesions were to be restored with composite. Regarding replacement of existing amalgam restorations by composite, the size and location of the restoration would determine suitability of the material. When replacement of existing restorations was to occur, half of these would be with composite.

Consequences

Since the expanded use of composite materials in posterior oral segments has only recently been introduced in the Dutch dental curricula, only fairly recently qualified dentists would be able to follow the indication as set in the scenario. Therefore, it was decided to force dentists to attend postgraduate courses on the use of composite in the scenario. These courses would take up approximately 1 week. In the scenario, within 5 years all dentist would have to attend these courses, taking up an average of 1 day of practice time annually, *i.e.* less possible working time.

Since one of the rationales behind the use of composite is the saving of tooth structure, using composite should eventually result in a postponement, or even in a definite reduction, of the number of coronal coverages by crowns. The same would apply to the number of teeth being extracted. In the model, a fraction of teeth is being crowned or extracted, depending for instance on age, dental attendance behaviour, and level of restoration of the teeth. No alterations to the influences of such variables were applied, but their total effect on the fraction of teeth being crowned, or extracted, would be reduced by 10% in 20 years time.

Generally, the use of composite in posterior regions requires more treatment time than when using amalgam instead. For this reason, the fees for composite restorations are

higher than for similar amalgam restorations. These extra fees for composite are taken into consideration in the model already. However, in the scenario it was set that regular dental attendees insured by NHS, who at present have to pay for certain composite restorations privately, would no longer have to pay that fee; the cost for all composite restorations would be covered by the NHS, analogous to the present situation with amalgam restorations. With respect to irregular dental attendees insured by NHS, they have to pay for their dental treatment until basic dental health has been established. No changes were applied to the model, since this practice is used irrespective of the restorative material.

There is uncertainty with regard to the true life expectancy of composite restorations. In the scenario, three possibilities are considered: 4 years, as present in the model as one third of that of amalgam restorations (Truin *et al.*, 1992), 8 years, and a life expectancy of 12 years.

8.2.2 Results

Scenario with life expectancy of 4 years

In the scenario with the life expectancy of composite restorations one-third that of amalgam, the utilisation level of dentists amounts to 5% more than in the new reference scenario by the year 2020: the work overload increases to 17%, due to the necessary treatment times. In Figure 8.1, the utilisation levels as found in this scenario and in the new reference scenario are shown. Striking in the utilisation level of the scenario is the initial peak, which subsequently turns into a gradual increase. At the same time, the cost of dentistry increases by 60 million Dutch guilders: a 3% increase to the new reference scenario.

The initial peak is compensated by an increase in the number of extractions, up to 5% more than the development in the new reference scenario. A decrease in the number of other dental treatments is present: 4% less preventive dental treatments, 3.5% less periodontal treatments, and 4–6% less restorations. The second, gradual, increase in utilisation level, is to be explained by an increase in the number of replacements of existing restorations, to 30% more than in the new reference scenario by the year 2020: 9.5 million treatments. The number of time-consuming dental treatments is further diminished (10% less fixed and removable partial dentures, 20% less complex dental restorations), whereas the number of new edentulous people is 8% more than in the new reference scenario, followed by the number of first complete dentures. By the year 2020, the increase in the total cost of dentistry has been stabilised at 30 million Dutch guilders (1.5%) above the new reference scenario.

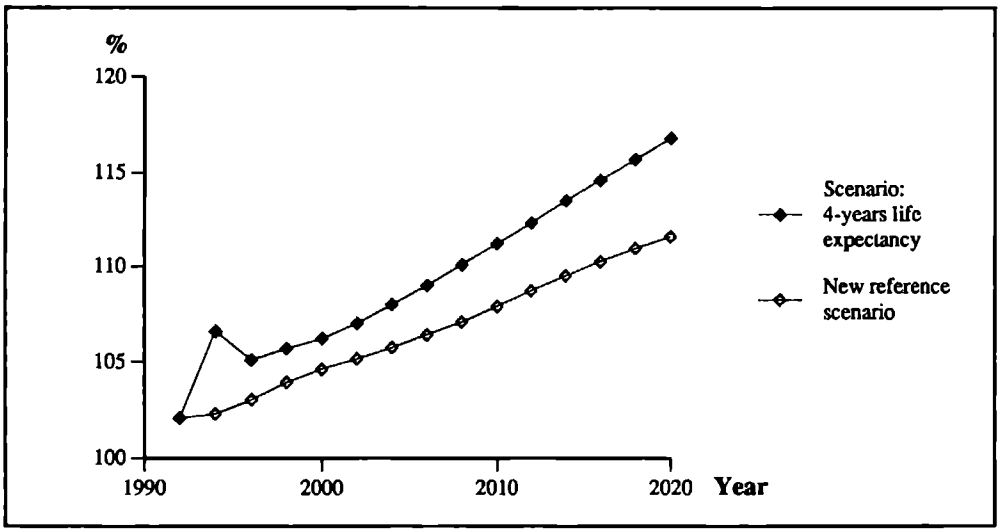
Scenarios with life expectancy of 8 and 12 years

The abovementioned results are modified to some extent, when the life expectancy of composite restorations is adapted.

If the life expectancy of composite restorations is set at 8 years, the utilisation level of dentists shows a similar picture as Figure 8.1, yet not reaching the same levels. The initial

sharp increase reflects a 2% increase relative to the new reference scenario. Compensation occurs by a 4% increase in the number of extractions, which is followed by a gradual 2% increase in the number of new edentulous persons; the number of replacements of existing restorations shows a 12% decline. Subsequently, an increase in the number of replacements of existing restorations to the same level as in the new reference scenario occurs; the utilisation level is raised to 2% above that of the new reference scenario again. A decline in the number of extractions that occurred after the initial peak in overload was compensated, is now levelling at 2% less than in the new reference scenario. A simultaneous and similar trend occurs in the number of new edentulous persons, which returns to only slightly above that of the new reference scenario. The total cost of dentistry is at maximum approximately 25 million Dutch guilders (1%) above that of the new reference scenario.

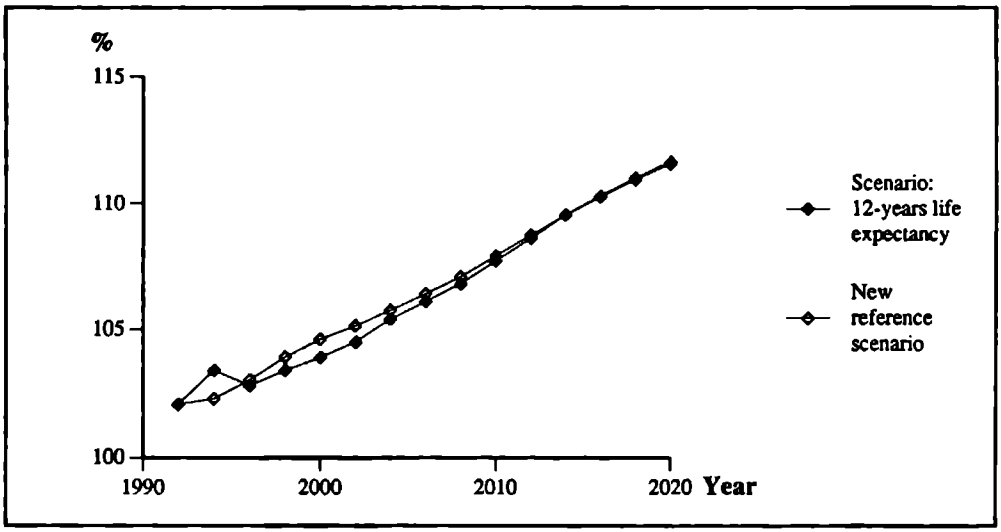
Figure 8.1 *Utilisation level of dentists in new reference scenario, and in scenario with 4-years life expectancy of composite restorations*



If the life expectancy of composite restorations is set at 12 years in the model, *i.e.* equal to that of amalgam, the utilisation level of dentists fluctuates around the level of the new reference scenario: it initially increases 1% over that reference scenario, then drops to nearly 1% less to end at reference level. In Figure 8.2 this phenomenon is visualised.

Initially, the number of extractions rises to 3% above that of the new reference scenario; the number of new edentulous persons shows a 1% increase. The number of replacements of existing restorations shows a sharp decline to 20% less than in the new reference scenario: 5.5 million treatments. After the initial peak in utilisation level, the number of extractions gradually decreases to 5% less than the new reference scenario; the number of new edentulous people drops to 3.5% below the reference scenario in the year 2020. The number of replacements of existing restorations stabilises at 20% less than in the reference scenario. A simultaneous increase in the number of other dental treatments can be observed: 2% more preventive dental treatments, 1.5% more periodontal treatments, 3% more fixed and removable partial dentures. Maximum deviation in the annual total cost of dentistry has been approximately 20 million Dutch guilders less than in the new reference scenario.

Figure 8.2 *Utilisation level of dentists in new reference scenario, and in scenario with 12-years life expectancy of composite restorations*



8.2.3 Conclusion

Key factor in the results of the scenarios has been the utilisation level of dentists. In the scenario with the life expectancy of composite restorations set at 4 years, the work overload of dentists is initially increasing. The dental profession subsequently tries to compensate

for this overload by an increase in the number of extractions (wiping out an effect of the preservation of tooth structure), and a decrease in the number of other dental treatments. This results in a diminishing overload, but a simultaneous increase in the number of people becoming edentulous. Due to the limited life expectancy of composite restorations, the number of replacements of these restorations increases after some time, once again leading to a steady increase in the utilisation level of dentists, and a further reduction in the number of time-consuming treatments. The overall result of this scenario can be expressed as a deterioration of general dental health status, with an increase in the number of new edentulous persons.

Upon increasing the life expectancy of composite restorations to 8 years, the work overload of dentists is less than in the former scenario. The extra time invested in applying composite instead of amalgam is balanced, as in the former scenario, by less replacements of restorations, by (slightly) more extractions, and by fewer other dental treatments (preventive, periodontal and complex restorative treatments), relative to the new reference scenario. Thus, the increase in the number of new edentulous people is still present, but diminished.

In the scenario in which the life expectancy of composite restorations is set equal to that of amalgam, the phenomena as present in the second scenario are emphasized. The initial increase in work load is smaller than in the two former scenarios, since less (time-consuming) replacements of restorations have to take place, due to the very increase in life expectancy. This increase is compensated as in the two former scenarios. The decline in utilisation level, offers the possibility for a greater diversity in performed dental treatments. The number of extractions, to reduce the workload, are further diminished; complemented by the effect of the preservation of tooth structure. It does not eventually diminish by 10%, as was set in the scenarios, due to the higher fees to be payed by Privately/not insured people, which increases the likelihood of extractions. Nevertheless, less persons than in the new reference scenario become edentulous. The total cost of dentistry was found to be more or less similar to that of the new reference scenario. The extra costs of the more expensive composite restorations, have been balanced by a decrease in the number of other expensive treatments, like for instance a smaller number of teeth needing coronal coverage, due to the preservation of tooth structure.

Under the assumptions as present in the model, and as formulated for the scenarios, it would thus seem advantageous to expand the use of composite, if a life expectancy equivalent to that of amalgam can be obtained. Notwithstanding investments in treatment time with the applying of composite instead of amalgam, a positive influence on the general dental health status can be obtained, by reducing the number of people becoming edentulous, without increasing the total cost of dentistry. However, would the life expectancy of composite restorations be less that that of amalgam restorations, a deteriorating dental health status could evolve, if no simultaneous increase in the amount of treatment time were to occur.

8.3 Scenario on the use of overdentures

Overdentures are associated with an increased stability and retention relative to conventional complete dentures, and with the preservation of alveolar bone by retaining roots or placing oral implants, thus helping to reduce the number of people with severe alveolar ridge resorption (Brewer & Morrow, 1975; Ramselaar & Kruysen, 1985; Basker *et al.*, 1988; Budtz-Jörgensen, 1991). However, with overdentures dental disorders may occur which do not occur with conventional complete dentures, *e.g.*, root caries and periodontal problems of the retained roots (Fenton & Hahn, 1978; Toolson & Smith, 1983; Shaw, 1984; Budtz-Jörgensen, 1991). Fortunately, antibacterial products have proven to be succesful in maintaining these retained roots (Keltjens *et al.*, 1990). Consequently, the follow-up regime of overdentures has to be more strict, and requires more effort and treatment time, than that of conventional complete dentures (Ettinger *et al.*, 1984; Kurer, 1986).

At present, in the dental curricula overdentures are the treatment of choice for persons becoming edentulous. Recently qualified dentists, and those newly qualifying, have been taught the theoretical rationale behind the use of overdentures, and may initiate an increase in the fraction overdentures of new complete dentures. Given the treatments involved with the preparation of overdentures *per se*, and the follow-up regime, this increase could have serious implications for dental health care. It remains unclear in what way and to what extent the effect on health care will be; it is even unclear today what the fraction overdentures of first complete dentures is (Van Rossum *et al.*, 1991b; De Baat, 1993; Results of the questionnaires - paragraph 7.3.1).

In order to investigate the implications of an expanding use of overdentures, a scenario was formulated with as central theme: "an overdenture is the new standard treatment for people becoming edentulous".

8.3.1 Model input

Fraction of overdentures

No differences were found in the results of the questionnaires between age groups, type of insurance (NHS or Privately/not insured) or dental attendance behaviour, regarding the fraction overdentures. Since the central theme of the scenario was that overdentures would be the new standard treatment for all, no distinction between these subgroups was entered into the scenario either. However, a certain number of people should be excluded from receiving the treatment, *e.g.*, because of their oral health behaviour, or their oral health status that makes it impossible to find suitable abutment teeth, or their inability to pay for the treatment. Dental attendance was considered in some way to reflect dental mindedness and dental health status; regular dental attendees being on the favourable side of the range compared to irregular dental attendees. Following this line of thought, of the regular dental attendees becoming edentulous, in the scenario 90% was to receive an overdenture, whereas

among the irregular dental attendees this was 50%. At population level, approximately three quarters of all persons becoming edentulous would receive overdentures instead of conventional complete dentures.

Treatment times

The extra time needed for treatment with overdentures is in the preparation of the abutment teeth, rather than in the preparing of the overdentures *per se*. Since root canal treatment can be thought the prime factor in this light, the extra time needed for treatment with overdentures was set at the time necessary to perform root canal treatments in abutment teeth. In 1993 a study was performed by the Dutch Endodontic Society, by means of a questionnaire sent to Dutch dentists. The, as yet unpublished, results revealed that an average of 29 minutes was needed by the general dental practitioner to complete a root canal treatment in a single-rooted tooth.

With respect to the number of abutment teeth, a miminum of 2 teeth per jaw was considered appropriate, probably expanded to 3 or 4 where possible and indicated. Taking also into consideration the possibility of two overdentures per person, an average of 3 abutment teeth was used in the scenario.

These assumptions result in 1.5 hour added treatment time with overdentures, relative to conventional complete dentures.

Costs

No special fees for treatment with overdentures are presently available in the Dutch health care system. The treatments are mostly considered to take place among dentate individuals; thus fees are calculated at the dentate level. Regarding root canal treatments, no additional fee for regular dental attendees insured by NHS is required; a standard fee is directly payed by the NHS to the dentist, in 1992 this was approximately 125 Dutch guilders for a single-rooted tooth, including necessary radiographs (Commissie Tandheelkundige Statistiek, 1992). Irregular dental attendees insured by NHS have to pay this fee themselves. With respect to Privately/not insured persons, the fee for the endodontic treatments was approximately 220 Dutch guilders (Nederlandse Maatschappij tot bevordering der Tandheelkunde, 1992); the fraction of the fee that would be covered by private insurance companies remained unchanged in the model.

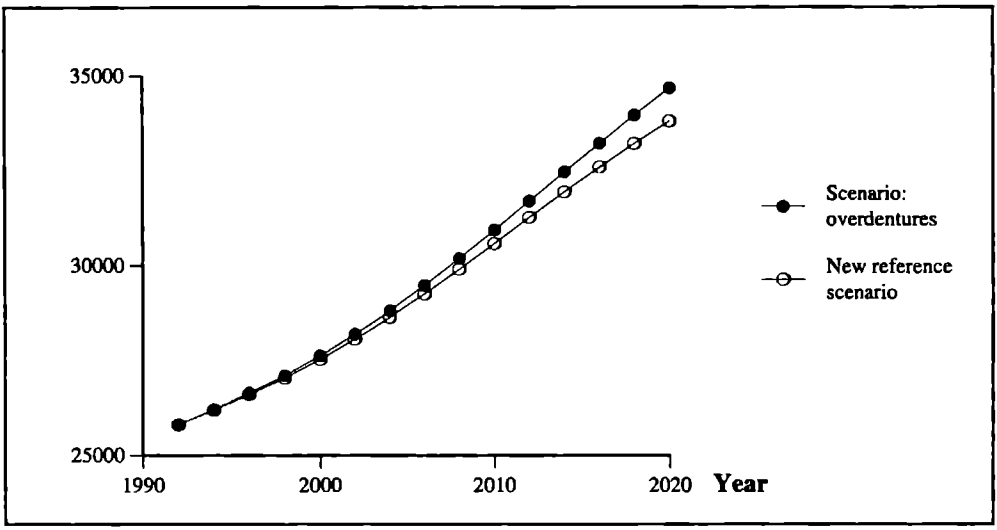
The extra costs in the treatment with overdentures was therefore set at 375 Dutch guilders for people insured by NHS, and 660 Dutch guilders for Privately/not insured people.

The presence of abutment teeth necessitates regular dental check-ups. Therefore, the recall frequencies of people wearing overdentures differs from that of those wearing conventional complete dentures. People wearing overdentures were considered to be dentate persons in the scenario. Following current education guidelines, the check-ups were set at twice a year. No extra professional fluoride applications were considered during these recalls; it was thought customary that people wearing overdentures apply topical antimicrobial agents themselves.

8.3.2 Results

The scenario showed a yearly increase of approximately 17,000 persons wearing overdentures, mounting to some 400,000 persons, out of approximately 1.7 million persons wearing complete dentures, by the year 2020. Due to the extra time for the treatment with overdentures, and the follow-up regime, the workload of dentists increases to 2% above the new reference scenario in the year 2020. Simultaneously, in the dentate persons not wearing overdentures, the number of extractions increases, whereas the number of time-consuming dental treatments decreases; the number of preventive dental treatments decreases by 3%, relative to the new reference scenario. The number of new edentulous persons gradually grows, to 3% more than in the new reference scenario, *i.e.* to approximately 35,000 people; consequently, the number of first complete dentures rises. In Figure 8.3, the changes over time in the number of new edentulous persons, of the scenario on the use of overdentures and of the new reference scenario, are depicted. Regarding the total cost of dentistry, a 15 million Dutch guilders decrease (0.75%) relative to the new reference scenario is present.

Figure 8.3 *Number of new edentulous persons in new reference scenario, and in scenario on the use of overdentures*



8.3.3 Conclusion

To lessen the increase in workload due to the extra time for the treatment with overdentures, and the follow-up regime, dentists adapt their treatment planning by increasing the number of extractions. This raises the number of new edentulous persons, resulting in an increasing number of first complete dentures. Besides the higher extraction rate, a decrease in the number of time-consuming dental treatments also diminishes the workload of dentists. The total cost of dentistry stays below that of the reference scenario, since the decrease in expensive treatments outweighs the increase in the number of root canal treatments as part of the preparing of overdentures. Interesting is a decrease in the number of preventive treatments: due to the increasing workload, less time is available for the dentate population. As a consequence, besides the already mentioned complex dental treatments, these simple dental treatments show a decline as well.

8.4 Discussion

As was shown by the scenarios, key factor in explaining the effects of the various options on dental health and health care, is the workload of dentists. If an overload occurs, a cascade of treatments is being performed to diminish this overload, but as a result the general dental health status deteriorates, with increased numbers of edentulous persons relative to the reference scenario. If the overload did not occur, possibly the effects of the various options would be different, since the influence of the dentist does not have to be of prime importance, but other variables may have essential effects on the results as well.

For this reason, the various scenarios were re-analysed while excluding the influence of utilisation level of dentists. This means that it is hypothesised that, in case of an undercapacity in meeting the demand for dental care, dentists will be flexible and willing to expand their working hours indefinitely in order to meet this demand. To show the effects of the various alterations to the model, the new reference scenario in which the influence of the workload of dentists was excluded, was compared with a similar scenario of the STG-project. Thereafter, the new reference scenario in which the influence of workload was excluded, served as reference for the scenarios on the use of composite and overdentures in which the influence of workload was excluded.

Reference scenario

When excluding the influence of workload of dentists, the number of extractions, and of persons becoming edentulous, were similar to those of the corresponding scenario of the STG-project. The number of replacements of existing restorations increased to 3% above the STG-project; the number of complex restorations increased to 2%, that of complex periodontal treatments to 3.5% above the STG-project. The number of treatments with fixed and removable partial dentures increased to 1.5% above the STG-project. The total

cost of dentistry was 1% above the 13% increase of the STG-project (to 2400 million Dutch guilders) in the year 2020; the utilisation level of dentists increased with 1% above that of the STG-project to 125%.

If there thus is capacity to meet the demand for dental care, small increases in the number of dental treatments can be expected with more people, dentate as well as edentulous, becoming regular dental attendees. An accompanying rise in the total cost of dentistry occurs. At the same time, the need for extractions is diminished, resulting in less new edentulous people; but, as a consequence, in more shortened or interrupted dental arches, hereby also increasing the number of fixed and removable partial dentures.

Scenarios on the use of composite

Upon excluding the influence of the utilisation level of dentists in the scenarios on the use of composite, a spectular increase in the number of replacements of existing restorations can be noted in the case of a 4-year life expectancy of composite restorations: 70% more by the year 2020 than in the new reference scenario in which the influence was excluded also. After an initial 1.5% increase, the number of extractions falls to slightly less than present in that new reference scenario, as a consequence of the assumptions of the scenario. This is followed by a similar trend in the number of first complete dentures. The total cost of dentistry rises to 250 million Dutch guilders (10%) above the new reference scenario in which the influence is excluded, by the year 2020. The utilisation level of dentists increased by 18% to 142%.

By increasing the life expectancy of composite restorations to 8-years, the number of extractions increases by an initial 1%, to fall to 1.5% less than in the new reference scenario in which the influence was excluded. The increase in the number of replacements of restorations is less pronounced than in the former scenario: it rises to 4% over the new reference scenario in which the influence is excluded, by the year 2020. This is followed by the total cost of dentistry, increasing to approximately 50 million Dutch guilders (2%) over the new reference scenario in which the influence is excluded, by the year 2020. The increase in utilisation level is 5% to 129%.

In the case of an equivalent life expectancy of composite and amalgam, exclusion of the influence of the overload of dentists results in only small differences between scenario and new reference scenario in which the influence was excluded, *e.g.*, an average per person of 0.3 less extracted teeth in people over 65 year of age insured by NHS, or an average of 0.4 less filled teeth in people over 45 years of age Privately/not insured in the scenario.

As was to be expected, an increase in the number of replacements of restorations was present in the case of a limited life expectancy of composite restorations; more composite restorations present, needing a quicker replacement than amalgam. The exclusion of the influence of workload of dentists, *i.e.* presence of an indefinite amount of treatment time, resulted in fewer extractions and in fewer edentulous people. The initial increase in the number of extractions, relative to the new reference scenario in which the influence was

excluded, is to be explained by the higher fees to be payed by Privately/not insured people, thus increasing the likelihood of extractions. The same reasoning can explain for the finding that the extraction rate does not eventually diminish by 10%, as was set in the scenario. When the life expectancy of composite approaches that of amalgam, the overload of dentists diminishes. By excluding the influence of the utilisation level of dentists, while simultaneously increasing the life expectancy of composite restorations, differences between the scenarios on composite and the new reference scenario, in which the influence of the overload of dentist was excluded, lessen as ultimately shown in case of an equivalent life expectancy of composite and amalgam.

Scenario on the use of overdentures

By excluding the influence of undercapacity of dentists, the number of new edentulous people returned to base line level, *i.e.* no changes relative to the values as found with the new reference scenario in which the influence was excluded as well. The same phenomenon occurred with respect to the various dental treatments. The total cost of dentistry moved from 15 million Dutch guilders less, to 4 million above (0.2%) that of the new reference scenario in which the influence was excluded, by the year 2020; the utilisation level increased by 3% to 127%.

Thus, in case of sufficient supply, the extra time needed in the preparation and follow-up of overdentures does not negatively affect the dental care for the dentate population anymore. Therefore, no variations in dental health status and dental care of the dentate population were present upon comparison with the new reference scenario in which the influence of the workload of dentists was excluded. The root canal treatments of the abutment teeth explain for the greatest part the increase in the total cost of dentistry.

In all, excluding the influence of the workload of dentists in the scenarios, the general dental health status is increasing relative to that of the scenarios in which the workload was included. This is mainly expressed in a higher degree of restorative care, with higher numbers of teeth being retained, and in less people becoming edentulous. The consequence of achieving this result, however, is an increase in the number of treatments being performed, an increase in dental manpower and, as a consequence, an increase in the total cost of dentistry.

CHAPTER

9

General discussion

The aim of this study was to obtain longitudinal data on aspects of the dental health status of Dutch adults, and to study the possible effects of observed changes in these aspects on future dental health and dental health care of the Dutch adult population.

In order to obtain longitudinal data, a follow-up study on the Dutch National Dental Survey (DNDS) of 1986 was conducted. The DNDS was a cross-sectional study on dental health of the Dutch adult population. Not only the prevalence of dental diseases, but also their possible etiologic factors, were measured. By questioning the same population after six years, it became possible to detect changes in dental health, and evaluate the effect of suspected etiologic factors. This follow-up study on the DNDS turned it into a cohort study. One aspect in cohort studies is the attrition of the study population over the follow-up period (Kleinbaum *et al.*, 1982): the loss of subjects due for instance to disinterest, changes in address, death. This may lead to a distortion of results of the follow-up study (selection bias). The efforts to prevent or minimise this selection bias, prior to the analysis stage, primarily involve ensuring as large a response rate to the follow-up as possible (Kleinbaum *et al.*, 1982). In the present study the maximum response rate was compromised, because a substantial number of persons had changed address, or had died. Also, it was found that some people were not interested in responding to the questionnaire, although they were willing to participate in some other part of the follow-up study, *i.e.* the intra-oral photographs. Cross-sectional studies supply essentially similar information as cohort studies, but one is better able to control the response rate. For this reason, successively performed cross-sectional studies may be better suited than cohort studies to obtain observational data. Several dental epidemiologic studies have used a cross-sectional study design (Brunelle *et al.*, 1988; Helöe *et al.*, 1988; Dowell & Evans, 1989; Evans & Dowell, 1990; Søgaard *et al.*, 1991; Reed *et al.*, 1993). In a largely descriptive study (*i.e.* an investigation in which time trends, such as changes in oral self care and in dental status, are studied), it may for this reason indeed be more appropriate to use cross-sectional rather than cohort studies. However, if the aim of the study is analytic (*i.e.* an investigation in which risk factors are identified, or the effect of variables on diseases are studied, such as variables influencing the change from a dentate to an edentulous status, and factors in having cosmetic dental treatment performed), not only the quantity but also the quality of data is of importance. It is then essential to know not only the presence of a disease, but also the presence of its etiologic factors, and the time relation between them (*e.g.*, Banting *et al.*, 1985; Hunt & Beck, 1985; Glass *et al.*, 1987; Hand *et al.*, 1991). Successive cross-sectional data cannot supply this kind of data (Kleinbaum *et al.*, 1982). Therefore, in analytic studies successive cross-sectional studies cannot replace cohort studies in order to discharge of possibly distorted results, stemming from a selective response.

One way to prevent a possible selection bias due to non-response in follow-up, while still having the ability to obtain longitudinal data on disease and its determinants, is the institution of so-called "monitoring practices". In a monitoring practice, a number of patients

is selected and regularly followed for the presence of disease and disease determinants. The data of the various monitoring practices are collected and analysed by a central data bank. Regarding dentistry, it is possible to draw a representative sample of Dutch dental practices, with a certain number of patients per practice, of whom dental information is obtained on a regular basis, *e.g.*, during periodic oral check-ups. A limitation of this design of data collection is that no information becomes available of people who do not visit a dentist; another possible source of selection bias.

In the analysis stage, the effects of selection bias on the results of the follow-up study can, besides a direct comparison on a certain aspect between the response group and the non-response group if these data are available, be studied by investigating whether a selectivity between respondents and non-respondents on relevant variables for the particular aspect has occurred. It may be that no selectivity is found, as with the edentulous respondents in the present study. If a selectivity on relevant variables is present, the ability to extrapolate the results beyond the study sample is compromised. In the present study, the results regarding cosmetic dental treatments were, for this reason, considered not to be representative for a larger Dutch population group. However, one may decide that the actual effect of a selectivity on relevant variables is of minor importance if a development that is observed in the response group is, to some extent, present in larger population groups already. In the present study, this was the case for the changes in dental attendance of dentate respondents, which were used in the generalisation process to national data, described in Chapter 7.

It was not possible to perform another survey as costly as the DNDS. Instead, a written questionnaire was used. This limited the aspects of Dutch adult dental health that could be measured in our follow-up study. For instance, no direct observations regarding carious and periodontal status could be made. It was possible, however, to assess the status in 1992 of the number of teeth present, the number of crowns/bridges and dentures, and to compare this information with the 1986-status. The self-assessment method as applied in this study has proved to be a valuable tool for obtaining this information. It offers an overview of a population's dental health status, and can easily be integrated into periodic population surveys. Furthermore, changes in dental attitude and behaviour in dentate and edentulous respondents could be studied, as well as some dental treatments that had been performed since 1986. No changes in the dentate respondents regarding oral hygiene behaviour could be identified. However, dental attendance for oral check-ups was observed to have increased, supporting expectations (Van Rossum & Kalsbeek, 1985; Swinkels, 1993). These data can also be considered to validate the system dynamic computer model of the Dutch dental health care system, as developed in the STG-project*, which forecast

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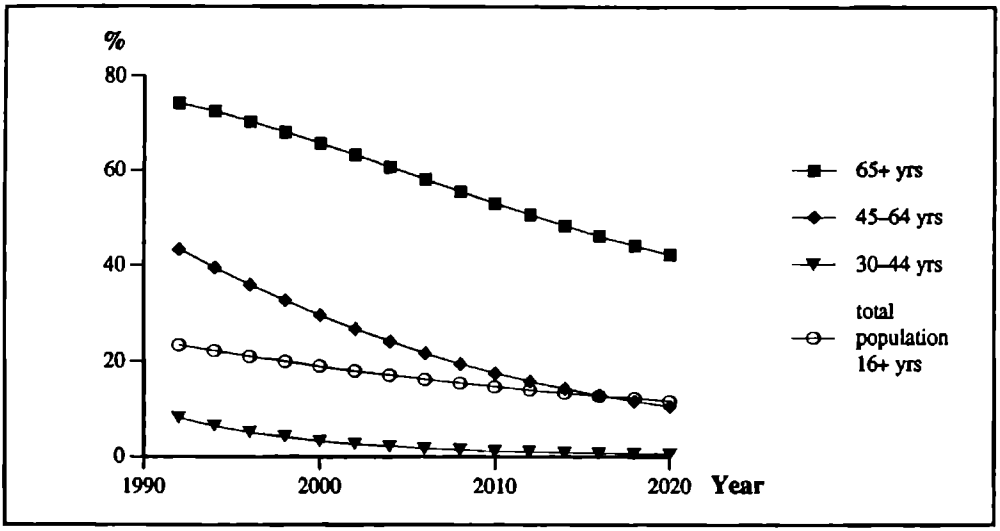
* Scenario Project on the Dutch dental health care system. Formulated at the Department of Cariology and Endodontology of the Dental School of the University of Nijmegen, the Netherlands, and subsidised by the so-called Steering Committee on Future Health Scenarios (Stuurgroep Toekomstscenario's Gezondheidszorg· STG).

the trend of a future increase in dental attendance for oral check-ups, albeit to a somewhat lesser extent. Demands for cosmetic dental treatments as reported on the questionnaire, were in line with expectations (Truin *et al.*, 1988; Burgersdijk *et al.*, 1991a). Regarding the number of persons becoming edentulous, the results were similar to national data (Central Bureau of Statistics, 1992); they also validated the model, because no deviations could be noted upon comparison with results as calculated by the model (Truin *et al.*, 1992). With respect to the persons wearing complete dentures, an increase in the number of dental visits was observed. This can be considered to support the opinion that, despite decreasing numbers of edentulous people, the future demand for dental care will remain at the present level (Bouma, 1989; Kalk *et al.*, 1992). A large proportion of first complete dentures was reported to be overdentures, which corresponds to current treatment philosophies (Jonkman & Plooij, 1992). This increase in the proportion overdentures may result in a decline of severe alveolar ridge resorption.

In order to integrate all this information into an overall picture of the future Dutch adult dental health status, a system dynamic computer model simulating the Dutch dental health care system was used. In general, the results as obtained from follow-up study on the DNDS, and subsequently used in the computer model, did not indicate substantial changes in future dental health status, relative to the forecasts of the STG-project (Truin *et al.*, 1992). An increase in the number of dental visits can be expected by increasing numbers of people, among them regular dental attendees, in the various age categories. The dental status is improving on an individual level, with an increase in the average number of sound teeth per person, and a decrease in the average number of missing and filled teeth per person. The average number of decayed teeth per person remains unaltered. The numbers of restorative dental treatments are fairly stable. With respect to periodontal diseases, the situation is likely to remain relatively stable for the age categories over 30 years, whereas a fall in the prevalence of periodontal disorders will occur in age category 19–29 years. As for treatment, an increase in the number of both simple and complex periodontal treatments can be expected. The demand for dental care will result in a work overload for dentists. This will be counteracted by increases in the total number of extractions, followed by the number of people becoming edentulous, although this will have little effect upon the total number of edentulous people because of the size of the edentulous population. Because of a considerable shift of 6 years in the average age at which people become edentulous (Truin *et al.*, 1992), and a simultaneous increase in the dentate population, there will be a change in the composition of the Dutch adult population. There will occur a decline in the proportion of edentulous persons in the various age categories over time, as well as a decline in the number of edentulous persons in the population as a whole. This phenomenon of declining fractions of edentulous persons in the various age categories is illustrated in Figure 9.1. As a result, the demand for the provision of complete dentures will decrease.

Figure 9.1 *Percentages edentulous persons per age category, and per total population ≥16 years of age*



Not so much the changes and trends in dental health status account for the differences in dental health status and dental health care that are projected to occur by the end of the simulation period, *i.e.* the year 2020; rather the demand for dental care, and the development of various treatment alternatives and modalities. These variables will be of great significance in respect of the workload of dentists, because of claims on treatments times. The factor "utilisation level of dentists", *i.e.* the relative undercapacity or overcapacity in meeting the demand for dental care, has proven to be crucial in explaining the observations of the scenarios. An undercapacity means that compensation will have to be sought for the increase in working hours above the equilibrium between demand and supply. This compensation may be found, for instance, in the postponement of time-consuming treatments, or in the solving of dental problems by forceps, rather than by dental rationale. Excluding the influence of this workload, could thus result in an improved general dental health status.

Upon excluding the influence of the utilisation level of dentists, the results of the new reference scenario regarding future developments of dental health status and dental health care were modified, in that the general dental health status was indeed improving, with less people becoming edentulous. The number of preventive dental treatments increased, as did the number of dental restorations and the number of periodontal treatments. There

was an increase in the number of regular dental attendees for whom these treatments are being performed, and there was adequate treatment time available to perform these treatments. More dental treatments were needed for the dentate population. However, from the economic viewpoint, the magnitude of their effects was limited: only a small increase in the total cost of dentistry could be noted.

With respect to the scenarios on the use of composite and overdentures, analogous observations can be made. With enough time available to meet the demand for dental care, extra investments in working time due to treatment alterations, no longer negatively affect dental health status and dental health care anymore.

Excluding the influence of the utilisation level of dentists in the model, means that there is enough manpower to meet the demand for dental care. One way to translate this indefinite availability of treatment time into practical measures, would be to delegate duties and work to other dental personnel; for example preventive and periodontal treatments to dental hygienists. This would allow dentists, for instance, to increase the amount of restorative dental work. However, in this light the relationship between the manpower potential of dental hygienist and of dentists is of importance. At present, the average number of clinical hours worked by dental hygienists is less than that by dentists; and the professional career of a dentist is much longer than that of a dental hygienist (Truin *et al.*, 1992). Also, an increase in the number of dental hygiene students enrolled would be necessary.

A second option may be the expansion of practice working hours. With the number of dentists who work part-time in dental practice, there is a potential for the expansion of working hours without the need to raise the number of dentists. However, over the last few years a trend has been noticable in the Netherlands of an increasing proportion of females practising dentistry. It has been reported that female dentists, more than their male colleagues, prefer to work part-time, rather than full-time (Van Dam & Van Rossum, 1993). The STG-project estimated that, as a consequence, in future a decrease in the number of practice working hours will occur. The population of dentists who have chosen to work part-time may not have the flexibility, or the willingness, to adapt their daily activities to spend more time in dental practice, and the actual effect of this option on the total amount of manpower may be marginal.

A third option to improve the availability of manpower would be to ensure a growing population of dentists. The present number of dentists qualifying from the two Dutch dental schools is unlikely to be able to cope with the future demand for dental care, as was shown in the STG-project and in the present study. A national intake of approximately 360 new dental students yearly, has been calculated to be necessary to eventually result in a utilisation level of dentists around the equilibrium status (Truin *et al.*, 1992). From our scenarios, in which the influence of the utilisation level of dentists was excluded, an increase in dental treatments, and an accompanying increase in the total cost of dentistry, is to be expected in such a situation. Truin *et al.* (1992) estimated this rise in costs to be approximately 580 million Dutch guilders, a 26% increase relative to their reference scenario, *i.e.* with

the current enrolment capacity of 180 new dental students yearly. However, the other side to these higher expenses, is the shift towards a better situation of the general Dutch dental health status. A classical example of a general conflict of interests: financial constraints on the one hand, and health ideals on the other.

Compendium

Summary
Samenvatting

Summary

The aim of this thesis was to study developments in aspects of dental health behaviour and dental health status in Dutch adults, and to study the consequences of these developments for future dental health and dental health care in the Dutch adult population.

In the **Introduction**, the importance of the collection of population data about dental health behaviour and dental health status is stressed: so as to be able to plan community dental health programs adequately, monitor changes in dental health, and evaluate the effects of the programs.

In **Chapter 1**, aspects of dental health behaviour and dental health status in Dutch adults, reported in the literature, are presented. As far as oral self care is concerned, oral hygiene behaviour has been fairly stable over the years; an improvement in dental attendance behaviour is present. The prevalence of coronal caries is thought to have declined over the last decades. Older adults have a worse status regarding dental caries than younger adults. It is evident that nearly every dentate adult experiences some form of periodontal disease, which increases in severity with advancing age. The percentage of people who are becoming edentulous is gradually decreasing.

As to future dental developments in the Netherlands, opinions diverge on the likely occurrence of dental caries and periodontal diseases, and their consequence on dental health care. However, there seems to be agreement that more teeth will be retained into advanced ages; that the average age at which people become edentulous is rising; and that the prevalence of edentulousness is decreasing. This is expected to result in a decline in the demand for complete dentures, and an accompanying decline in the occurrence of severe alveolar ridge resorption.

Chapter 2 describes the methods used in the present study to analyse changes in dental health behaviour and dental health status in Dutch adults over the last years. A follow-up study was performed on the Dutch National Dental Survey of 1986 (DNDS). A written questionnaire was used to obtain information on aspects of dental health behaviour and dental health status. Two types of questionnaire were used. One sent to persons known from the DNDS to be dentate in at least one jaw; the other to edentulous people. The questionnaire sent to dentate persons was supplemented with a form for self-assessment of dental status. This method of self-assessment proved to be unsuitable for obtaining valid data, at an individual level, on the actual location of teeth and crowns/bridges. However, it is considered to be a valuable method for estimating at a relatively low cost, at a population level, the number of teeth, crowns/bridges and removable dentures present.

In Chapters 3 to 6, data obtained from the questionnaires are presented. In **Chapter 3**, the oral self care of dentate adults is considered. No changes in dental hygiene behaviour were found upon comparison of the follow-up data with the DNDS data. However, changes in dental attendance behaviour were present: a shift towards shorter intervals since the last dental visits for oral check-ups was noted among the respondents, with a simultaneous

decrease in the number of dental visits that were made because of dental complaints. It is concluded that this phenomenon was the consequence of a general increase in dental health motivation.

Chapter 4 is concerned with cosmetic dental treatment, as performed for the respondents since 1986. Two types of treatment were considered: first, cosmetic dental treatment with veneers on anterior teeth, and secondly, replacement of amalgam restorations with composite or porcelain in premolars and molars. Treatment with veneers was reported by 10% of the respondents; replacement of amalgam restorations by 19%. Thus, 25% of the respondents reported some cosmetic dental treatment. This percentage is thought to be lower on a national scale, given a selectivity in response on a relevant variable for having cosmetic dental treatment performed: the objective cosmetic dental treatment need.

In **Chapter 5**, the change from dentate to edentulous status is addressed. Only 3% of the respondents had changed from a dentate status in 1986 to an edentulous status in both jaws in 1992; either wearing conventional complete dentures, or overdentures. Those who had become edentulous in at least one jaw, represented 6% of the respondents. These figures on the incidence of edentulousness were found to be in accordance with other recent national data, and are considered to reflect those of the Dutch population.

Chapter 6 describes the dental attitude and behaviour of those Dutch adults who wore complete dentures during the DNDS. In this group of people, the number of dental visits for denture check-ups and for treatment of denture complaints, had increased since 1986. Regarding the wearing of complete dentures, there was a shift from wearing them day and night, towards wearing them only during the day. No changes in the perception of denture satisfaction were observed. Denture treatments were reported by 31% of the respondents. The results are considered to reflect actual changes among Dutch adults wearing complete dentures. The trends which have been identified indicate a likely increasing demand for dental health care by the edentulous population.

In Chapter 7 and 8, the results obtained from the questionnaires are used as an input to a system dynamic computer simulation. Such simulation studies offer the possibility of integrating a variety of information. In the present study, a system dynamic computer model of the Dutch dental health care system was used to integrate the data obtained from the follow-up study into an overall picture of possible future developments in dental health behaviour, dental health status, and dental health care of the Dutch adult population.

In **Chapter 7**, the use of the system dynamic computer model is described. After incorporating the appropriate follow-up data in the model, to change parameters, the results of the model are described by its so-called reference scenario. It showed the probability of future improvements of individual dental health status. However, it also showed a future conflict between demand and supply: demand for dental health care by a growing adult population with increasing numbers of regular dental attendees, and increasing numbers of dental visits; and the supply of this care by dentists. As a consequence, dentists likely

will reduce the number of time-consuming dental treatments, and increase the number of extractions so as to reduce, at least in part, the manpower undercapacity in meeting the demand for dental health care. However, this would result in a deterioration in the general dental health status: increasing numbers of people who become edentulous.

In **Chapter 8**, two scenario analyses are presented: one on the use of composites, the other on the use of overdentures. The key factor in explaining the results of these scenarios is, once again, the conflict between demand and supply. It would seem advantageous to expand the use of composites if a life expectancy equivalent to that of amalgam can be obtained: a positive influence on the general dental health status can be obtained. However, this under the assumptions as present in the model and as formulated for the scenarios. With respect to the use of overdentures, the conflict between demand and supply will result in increasing numbers of extractions and of people becoming edentulous. It will also lead to a decrease in the number of time-consuming dental treatments, and to a decrease in the number of preventive dental treatments in the dentate population.

To study the actual effects of the incorporation of the follow-up data in the computer model, the various scenarios were re-analysed, this time excluding the influence of the conflict between demand and supply. That is to say, by assuming an unlimited supply of dental treatment time. This led to improvements in dental health status: a higher degree of restorative care, greater numbers of teeth being retained, and fewer people becoming edentulous. However, the consequence of achieving this result would be an increase in the number of dental treatments delivered, and consequently an increase in the total cost of dental health care.

Chapter 9 is a general discussion on methods and results. First, the methods of obtaining population data are discussed. The difference between a descriptive and an analytic epidemiologic survey regarding data collection is discussed, as is the influence of non-response in light of selectivity in results. In an analytic study, the availability of follow-up data is mandatory. To limit the distorting effect of attrition of subjects during the follow-up phase, the institution of "monitoring practices" would be an option.

The inability of dentists to meet the demand for dental care has proved to be crucial in explaining the observations, regarding future developments in dental health, of the various scenarios. By considering the situation of an unlimited supply of dental treatment time, improvements in dental health status evolve. Means of realising this option may include the expansion of practice working hours, or the delegation of some dental work to other dental personnel, such as dental hygienists. It is concluded that these options have some limitations in their applicability. More appropriate would be an increase in the number of dentists, by an expansion in the Dutch national enrolment capacity for dental students.

Samenvatting

Het doel van dit proefschrift "Aspecten van tandheelkundige gezondheid in Nederlandse volwassenen; veranderingen en consequenties" was tweeledig. Ten eerste het bestuderen van ontwikkelingen in bepaalde aspecten van het tandheelkundige gezondheidsgedrag en de gebitssituatie van Nederlandse volwassenen. Ten tweede het bestuderen van de gevolgen van deze ontwikkelingen op de toekomstige tandheelkundige gezondheid en gezondheidszorg.

In de **Introductie** wordt ingegaan op het belang van het verzamelen van bevolkingsgegevens over tandheelkundig gezondheidsgedrag en gebitssituatie. Hiermee wordt het namelijk mogelijk op adequate wijze projecten op het gebied van Tandheelkundige Gezondheidsvoorlichting en -Opvoeding (TGVO) op te stellen, veranderingen in gebitsgezondheid waar te nemen en het effect van TGVO-projecten te evalueren.

In **hoofdstuk 1** worden aan de hand van literatuurgegevens aspecten van de tandheelkundige gezondheid van volwassen Nederlanders behandeld. Met betrekking tot het zelfzorggedrag blijkt in de loop der jaren weinig variatie waar te nemen in de gebitsverzorging; wel veranderde het tandartsbezoek. Wat tandheelkundige pathologie betreft, lijkt in de laatste decennia de prevalentie van cariës bij jonge volwassenen te zijn afgenomen; bij oudere volwassenen zijn de gevolgen van cariës in grotere mate aanwezig dan bij jongeren. Verder vertoont vrijwel elke volwassene enige vorm van parodontale aandoening; de ernst hiervan neemt toe met toenemende leeftijd. Het percentage mensen dat edentaat wordt, is de laatste decennia geleidelijk gedaald.

Er bestaan in de literatuur geen eensluidende toekomstverwachtingen omtrent het optreden van cariës en parodontale aandoeningen en de gevolgen daarvan voor de tandheelkundige gezondheidszorg. Wel wordt verwacht dat in de toekomst meer gebitselementen tot op hogere leeftijd behouden zullen blijven, dat de gemiddelde leeftijd waarop mensen edentaat worden hoger wordt, en dat het aantal edentate personen afneemt. Het gevolg hiervan is een afnemende vraag naar behandeling met volledige gebitsprothesen en een afnemend aantal mensen met ernstige reductie van het alveolaire kaakbot.

In **hoofdstuk 2** worden de methoden beschreven waarmee recente veranderingen in tandheelkundige gezondheid van Nederlandse volwassenen zijn onderzocht. Hiertoe werd een vervolgonderzoek op het in 1986 uitgevoerde Landelijk Epidemiologisch Onderzoek Tandheelkunde (LEO-T) uitgevoerd. Teneinde informatie te vergaren over aspecten van tandheelkundige gezondheid werd gebruik gemaakt van een enquête. Per post werden vragenlijsten verstuurd die na invulling in antwoord-enveloppen dienden te worden geretourneerd. Twee verschillende vragenlijsten werden gebruikt: één voor personen die ten tijde van het LEO-T in ten minste één kaak dentaat waren, de andere voor de personen die toentertijd edentaat waren. De vragenlijst voor dentate personen werd vergezeld van een formulier waarop de geënquêteerden zelf hun gebitsstatus konden invullen. Deze methode

van "zelfbeoordeling" van de gebitsstatus blijkt ongeschikt om op individueel niveau betrouwbare gegevens te verzamelen over de plaats van gebitselementen en van prothetische voorzieningen. De methode blijkt wel geschikt om op een goedkope manier binnen een populatie het aantal aanwezige gebitselementen, gegoten voorzieningen, en gebitsprothesen te bepalen.

In de hoofdstukken 3 tot en met 6 worden de gegevens die met de vragenlijsten zijn verkregen, geanalyseerd. **Hoofdstuk 3** behandelt het tandheelkundig zelfzorggedrag van de dentate volwassenen. In vergelijking met de LEO-T gegevens konden bij de respondenten geen veranderingen in mondhygiënegedrag worden waargenomen. Wel was een verschuiving in tandartsbezoek aanwezig: de tijd verlopen sinds het laatste periodieke controlebezoek was korter dan in 1986, terwijl het aantal klachtenbezoeken was afgenomen. Geconcludeerd wordt dat een algemene verbetering in tandheelkundige motivatie ("dental mindedness") aan deze verschuiving ten grondslag ligt.

Hoofdstuk 4 gaat in op cosmetische tandheelkundige behandelingen. Er werd onderscheid gemaakt tussen behandeling van frontelementen met "veneers" en het vervangen van amalgaamrestauraties in de zijdelingse delen door restauraties van composiet of porselein. Cosmetische behandeling met veneers werd gerapporteerd door 10% van de respondenten, amalgaamvervanging door 19%. In totaal had 25% van de respondenten enige cosmetische tandheelkundige behandeling laten uitvoeren. Aangenomen wordt dat dit percentage landelijk gezien lager is, aangezien de respondenten selectief bleken op een relevante variabele voor het laten uitvoeren van deze behandelingen: de objectief vastgestelde cosmetische behandelbehoefte.

In **hoofdstuk 5** wordt ingegaan op de overgang van een dentate gebitssituatie naar een edentate. Slecht 3% van de respondenten rapporteerde edentaat te zijn geworden sinds 1986. Het percentage personen dat in minstens één kaak edentaat was geworden, was 6. Deze gegevens blijken overeen te komen met andere recente landelijke gegevens over de overgang naar een edentate gebitssituatie.

Hoofdstuk 6 beschrijft de tandheelkundige attitude en het tandheelkundige gezondheidsgedrag van edentate respondenten. Het aantal bezoeken voor controle of behandeling van de gebitsprothese was toegenomen sinds 1986. Tevens viel een verschuiving waar te nemen in het draaggedrag van de gebitsprothese: van dag en nacht in 1986, naar alléén overdag in 1992. Geen veranderingen konden worden waargenomen in de tevredenheid met de gebitsprothese. Door 31% van de respondenten werd gerapporteerd dat sinds 1986 behandelingen aan de gebitsprothesen waren uitgevoerd. Van deze gegevens wordt aangenomen dat zij de situatie binnen de bevolkingsgroep van volwassen Nederlanders die een gebitsprothese dragen weergeven. Er kan rekening worden gehouden met een toenemende vraag naar tandheelkundige behandelingen vanuit deze bevolkingsgroep in de toekomst.

In de hoofdstukken 7 en 8 worden gegevens die met de enquêtes zijn verkregen, gebruikt in zogenaamde computersimulaties. Met behulp van zulke simulaties kan een verscheidenheid

aan gegevens worden geïntegreerd. Voor dit proefschrift houdt dit in dat een beeld kan worden geschetst van toekomstige ontwikkelingen in tandheelkundig gezondheidsgedrag, gebitssituatie en tandheelkundige gezondheidszorg van de volwassen Nederlandse bevolking.

In **hoofdstuk 7** wordt het gebruikte computermodel geïntroduceerd. Vervolgens worden de met de enquêtes verkregen gegevens getoetst op en bewerkt voor geschiktheid voor invoer in dit model en worden de toekomstverwachtingen beschreven. Deze laten op individueel niveau een verbetering van de gebitsgezondheid van de volwassen Nederlanders zien, maar tevens een verslechtering van de gebitsgezondheid op bevolkingsniveau. Dit laatste kan worden gerelateerd aan een toenemende vraag naar tandheelkundige zorg vanuit de bevolking. Deze vraag is zo groot dat de tandartsen hier niet zonder meer aan kunnen beantwoorden. Dit zal bij de tandartsen waarschijnlijk leiden tot het verminderen van het aantal tijdrovende behandelingen en het vermeerderen van het aantal extracties van gebitselementen om, tenminste ten dele, aan de vraag naar tandheelkundige zorg tegemoet te kunnen komen. Echter, het gevolg zou zijn dat een toenemend aantal mensen edentaat wordt, hetgeen de algemene gebitsgezondheid doet verslechteren.

In hoofdstuk 8 worden twee "scenario-analyses" gepresenteerd: één betreffende het gebruik van composieten, de ander betreffende de toepassing van overkappingsprothesen. Met behulp van deze scenario-analyses kunnen mogelijke effecten van voorgestelde veranderingen worden onderzocht; dit evenwel gebaseerd op aannames die zijn ingebouwd in het computermodel en die zijn geformuleerd voor de scenario's. Zo blijkt het aan te bevelen om het gebruik van composiet te verruimen wanneer de duurzaamheid van dit materiaal gelijk is aan die van amalgaam: de algemene gebitsgezondheid zou verbeteren. Met betrekking tot een toenemende toepassing van overkappingsprothesen geldt dat het aantal extracties van gebitselementen zou gaan toenemen, evenals het aantal mensen dat edentaat wordt. Bij de dentate bevolking zou een reductie gaan optreden in het aantal preventieve en restauratieve behandelingen.

Teneinde de eigenlijke effecten van de in de scenario's voorgestelde veranderingen te kunnen onderzoeken, zijn de diverse scenario's opnieuw geanalyseerd. Hierbij werd uitgegaan van een ongelimiteerd aanbod aan tandheelkundige behandeltijd. Hiermee zijn verbeteringen in gebitsgezondheid te bereiken: een hogere restauratieve verzorgingsgraad, meer gebitselementen die behouden blijven en minder mensen die edentaat worden. De consequentie is echter een toeneming van het aantal tandheelkundige behandelingen. Daarmee stijgen ook de kosten van de tandheelkundige zorgverlening.

Hoofdstuk 9 is de algehele discussie van dit proefschrift. Mogelijke methoden om bevolkingsgegevens te verzamelen worden besproken. Hierbij is het verschil tussen een beschrijvend en een analyserend epidemiologisch onderzoek van belang. Geconcludeerd wordt dat voor een analytisch onderzoek longitudinale gegevens beschikbaar moeten zijn. Teneinde het mogelijk vertekenende effect van "non-respons" tijdens de vervolgstudie(s)

te reduceren, zou het gebruik van "peilstations" een methode van gegevensverzameling kunnen zijn.

Het conflict tussen vraag naar en aanbod van tandheelkundige zorgverlening bleek cruciaal in het verklaren van de resultaten van de scenario's. Door het veronderstellen van een ongelimiteerd aanbod aan tandheelkundige behandeltijd viel een verbetering in tandheelkundige gezondheid waar te nemen. De "vertaling" van dit ongelimiteerde aanbod naar de werkelijkheid zou kunnen liggen in het uitbreiden van de tandheelkundige behandeltijd door de huidige tandartsen, of in het delegeren van bepaalde werkzaamheden naar tandheelkundige hulpkrachten, zoals mondhygiënisten. Deze opties hebben echter enkele beperkingen in hun toepasbaarheid. Waarschijnlijk beter toepasbaar is de uitbreiding van het aantal tandartsen, bijvoorbeeld door een uitbreiding van de opleidingscapaciteit voor tandheelkunde-studenten.

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Appendices

I Questionnaire to dentate population
II Self-assessment form
III Questionnaire to edentulous population

Questionnaire addressed to people known from DNDS to be dentate in at least one jaw. Reduced from A4 format; translated from Dutch.

How to fill out this questionnaire.

You are kindly requested to mark the box behind the answer of your choice. Only one answer per question should be marked, unless it is specifically stated otherwise.
A few questions allow you to write down an alternative answer of your own.

Please answer the questions in the given order. If you are to skip a question, this will be indicated after a specific answer (where it will say: ➔ *go on to question* ...) If the answer you have chosen is not followed by such an instruction, proceed to the next question.

Take your time to read the questions, before choosing the answer that is most appropriate in your case.

Address label

If the personal information on the label above is incorrect or outdated, please correct it below (use block capitals, please):

Correct name:_____

Correct address:_____

_____

Correct date of birth:_____

1. Are you insured against dental health care?

yes ☐
no ☐ → *go on to question 5*

2. How are you insured against dental health care?

NHS ☐
privately ☐ → *go on to question 5*
civil-service insurance (e.g., IZA/IZR/DGVP) ☐ → *go on to question 5*

3. If the NHS would drop the requirement to have a dental check-up every 6 months, would you still visit a dentist for a check-up every 6 months?

yes ☐ → *go on to question 5*
I don't know ☐ → *go on to question 5*
no ☐

4. If not, how often would you visit a dentist?

once every year ☐
once every 2 years ☐
once every 3 years ☐
less than once every 3 years ☐
I would not visit a dentist at all ☐

5. Do you still have any (natural) teeth of your own?

yes ☐
no ☐ → *go on to question 33*

6. How many times per day do you normally brush your teeth?

0 times ☐
1 time ☐
2 times ☐
3 times ☐
more than 3 times ☐

7. Apart from a toothbrush and toothpaste, do you use any dental cleaning aids?

yes ☐
no ☐ → *go on to question 10*

8. Please indicate which cleaning aids you use. You can mark more than one answer, if it is appropriate in your case.

toothpicks ☐
dental floss ☐
mouth wash ☐
powder/polishing products/etc. ☐
something else, viz.:_____
_____

9. How frequently do you use these cleaning aids?

every day ☐
not every day, but several times a week ☐
once a week ☐
not once a week, but several times a month ☐
once a month ☐
not once a month, but several times a year ☐

10. In your opinion, should dental health care be included in the new national health care insurance program that the government is planning to set up?

yes ☐
no ☐

11. If dental health care was not included in this new national health care insurance program, would you take out an additional insurance against dental health care?

yes ☐
no ☐ → *go on to question 14*

12. If this additional dental health care insurance would only cover basic dental care, such as check-ups, fillings and removal of calculus (about the present NHS coverage), what would be the highest monthly premium you would be prepared to pay? (Assuming the insurance does not have a refund threshold)

Df 10,- per month
Df 20,- per month
Df 30,- per month
Df 40,- per month
Df 50,- per month
Df 60,- per month
Df 70,- per month
more than Df 70,- per month

13 If this additional dental health care insurance would also cover the costs of more extensive dental treatment, such as crowns and bridges, what would then be the highest monthly premium you would be prepared to pay? (Again assuming the insurance does not have a refund threshold)

Df 10,- per month
Df 20,- per month
Df 30,- per month
Df 40,- per month
Df 50,- per month
Df 60,- per month
Df 70,- per month
more than Df 70,- per month

14 Suppose this year you would be given the choice: either you have all your teeth properly treated and restored or you have them all extracted What is the total cost you would at this moment be prepared to pay for the total restoration of all your teeth, out of your own pocket?

nothing
Df 1,- to Df 200,-
Df 201,- to Df 600,-
Df 601,- to Df 1000,-
Df 1001,- to Df 1500,-
Df 1501,- to Df 2500,-
Df 2501,- to Df 4000,-
Df 4001,- to Df 8000,-
Df 8001,- to Df 10 000,-
Df 10 001,- or more

15. When did you last visit a dentist for a dental **check-up**?

- 0 - 6 months ago ☐
- 7 - 12 months ago ☐
- 13 - 24 months ago ☐
- 2 - 5 years ago ☐
- more than 5 years ago ☐
- I have never visited a dentist for a check-up ☐

16. Did you (also) visit a dentist for **another** reason?

- yes ☐
- no ☐

17. Have you ever visited a dental hygienist?

- yes ☐
- no ☐ → *go on to question 19*

18. When did you last visit a dental hygienist?

- 0 - 6 months ago ☐
- 7 - 12 months ago ☐
- 13 - 24 months ago ☐
- 2 - 5 years ago ☐
- more than 5 years ago ☐

19. During the past 5 years, did you visit a dentist, periodontist, or oral surgeon for a **special** treatment of your gums (we do not mean the normal removal of calculus)?

- yes ☐
- no ☐

20. Do you have any complaints concerning your gums and/or teeth at this moment?

- yes, I have a problem with my gums ☐
- yes, I have a problem with my teeth ☐
- yes, I have problems with both my gums **and** teeth ☐
- no, I have no problems ☐ → *go on to question 22*

21. What are the complaints concerning your gums and/or teeth at this moment? You can mark more than one answer, if it is appropriate in your case.

painful gums ☐
tooth ache ☐
bleeding gums ☐
bad taste / bad breath ☐
swollen gums ☐
mobility of teeth ☐
receding gums ☐
spaces between the teeth that were not there before ☐
changes in tooth position (lengthening or tipping of teeth) ☐
discoloured teeth ☐
cavities ☐
loose or lost fillings ☐
other complaints, viz.:_____
_____

22. Have you had one or more metal (amalgam) fillings, in your (pre)molar teeth, replaced by white fillings?

yes ☐
no ☐ → *go on to question 24*

23. How many of these metal fillings in (pre)molar teeth have been replaced by white fillings?

1 or 2 ☐
3 or 4 ☐
5 or 6 ☐
7 or 8 ☐
more than 8 ☐

24. Have any of your front teeth been covered by a white material (a veneer) to make them more pleasing to look at?

yes ☐
no ☐ → *go on to question 26*

25. How many front teeth have been covered by this white material?

1 or 2 ☐
3 or 4 ☐
5 or 6 ☐
7 or 8 ☐
more than 8 ☐

26. Do you wear a removable partial denture to replace some of your upper or lower teeth?

yes, I have an all plastic partial denture ☐
yes, I have a partial denture with metal grips ☐
yes, I have an all plastic partial denture **and** a partial denture with metal grips ☐
no ☐ → *go on to question 33*

27. Do you wear this partial denture in the upper or the lower jaw?

in the upper jaw only ☐
in the lower jaw only ☐
in the upper **and** the lower jaw ☐

28. Did you get this partial denture during the past 5 years?

yes, this is my first partial denture ☐
yes, this replaces a previous partial denture ☐
no, it is older than 5 years ☐ → *go on to question 30*

29. What was the reason you got the present partial denture? Please indicate the one reason that was decisive for you.

my teeth were too broken down ☐
I had constant tooth aches ☐
my teeth were constantly inflamed ☐
my gums could not be treated anymore ☐
I couldn't stop the deterioration of my teeth by brushing ☐
I had problems eating / chewing food ☐
my previous partial denture needed to be replaced ☐
my dentist advised me to ☐
another reason, viz.:_____

_____

30. Are you satisfied with your present partial denture?

very satisfied ☐ → *go on to question 33*
satisfied ☐ → *go on to question 33*
neither satisfied nor dissatisfied ☐ → *go on to question 33*
dissatisfied ☐
very dissatisfied ☐

31. Why are you dissatisfied with your present partial denture? You can mark more than one answer, if it is appropriate in your case.

it hurts me ☐
it is loose ☐
I don't like the way it looks ☐
I have trouble talking ☐
I have trouble swallowing ☐
I have trouble eating ☐
another reason, viz.:_____

_____

32. Would you like to have your present partial denture changed in the near future?

yes, I should like to have it changed / adjusted ☐
yes, I should like to have it replaced ☐
no, I don't want anything done about it ☐

33. Do you wear a complete denture in the upper and/or lower jaw?

yes, in the upper jaw only ☐
yes, in the lower jaw only ☐
yes, in the upper jaw **and** the lower jaw ☐
no ☐ → *go on to 36*

34. Were any roots preserved in your jaws to improve the retention of the complete denture(s)?

yes ☐
no ☐

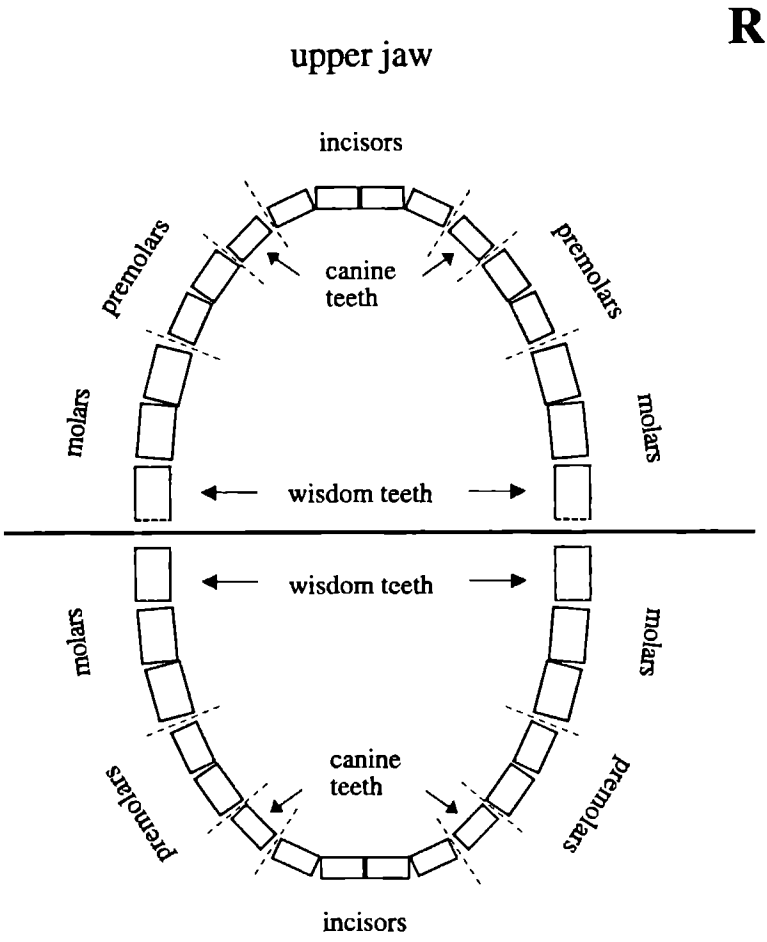
35. Did you have dental implants placed to improve the retention of the complete denture(s)?

yes ☐
no ☐

36. You have come to the end of the questionnaire. Thank you very much for your cooperation!

You can use the enclosed return envelope to send us your completed questionnaire; no postage is required.

Self-assessment form, complementary to questionnaire to dentate population. Reduced from A4 format; instructions translated from Dutch.



Standing in front of a mirror, please indicate on the form:

- with a cross through the tooth or teeth, those that have been extracted;
- with a circle around the tooth or teeth, those that have been crowned.

If a removable denture is present, you can draw this on the form. Please remove the denture before indicating the teeth that have been extracted or crowned.

Questionnaire addressed to people known from DNDS to be edentulous. Reduced from A4 format; translated from Dutch.

How to fill out this questionnaire

You are kindly requested to mark the box behind the answer of your choice Only one answer per question should be marked, unless it is specifically stated otherwise
A few questions allow you to write down an alternative answer of your own

Please answer the questions in the given order If you are to skip a question, this will be indicated after a specific answer (where it will say → go on to question) If the answer you have chosen is not followed by such an instruction, proceed to the next question

Take your time to read the questions, before choosing the answer that is most appropriate in your case

---

Address label

If the personal information on the label above is incorrect or outdated, please correct it below (use block capitals, please)

Correct name _____

Correct address _____

_____

Correct date of birth _____

1 Are you insured against dental health care?

yes
no → *go on to question 3*

2 How are you insured against dental health care?

NHS
privately
civil service insurance (e g , IZA/IZR/DGVP)

3 When did you last visit a dentist or a dental technician for a **check-up**?

0 - 6 months ago
7 - 12 months ago
13 - 24 months ago
2 - 5 years ago
more than 5 years ago
I have never visited anybody for a check-up → *go on to question 5*

4 For this check-up, did you visit a dentist or a dental technician?

dentist
dental technician

5 Did you (also) visit a dentist or a dental technician for **another** reason?

yes
no (→ *go on to question 8)*

6. Did you, at that time, visit a dentist or a dental technician?

dentist
dental technician

7. For what other reason(s) did you visit a dentist or dental technician? You can mark more than one answer, if it is appropriate in your case.

my dentures were broken ☐
a tooth was missing from my dentures ☐
my dentures were worn out ☐
I didn't like the way my dentures looked anymore ☐
my dentures were hurting me ☐
my dentures were coming loose ☐
I had trouble talking ☐
I had trouble swallowing ☐
I had trouble eating / chewing food ☐
I was advised to go ☐
another reason, viz.:_____
_____

8. Do you visit a dentist or a dental technician the moment you find there is something wrong with your dentures?

yes ☐
no ☐

9. Did you have your dentures replaced during the past 5 years?

yes, the upper denture was replaced ☐
yes, the lower denture was replaced ☐
yes, both upper **and** lower denture were replaced ☐
no ☐ → *go on to question 12*

10. What was, for you, the one decisive reason for replacing your old dentures? Please mark only one answer.

my dentures were broken ☐
a tooth was missing from my dentures ☐
my dentures were worn out ☐
I didn't like the way my dentures looked anymore ☐
my dentures were hurting me ☐
my dentures were coming loose ☐
I had trouble talking ☐
I had trouble swallowing ☐
I had trouble eating / chewing food ☐
I was advised to go ☐
another reason, viz.:_____
_____

11. For these new dentures, did you go to a dentist or a dental technician?

dentist	☐
dental technician	☐

12. Do you wear your dentures?

yes, but only my upper denture	☐	
yes, but only my lower denture	☐	
yes, I wear my upper **and** lower denture	☐	
no, I don't wear my dentures	☐	→ *go on to question 14*

13. When do you wear your denture(s)?

during the day and night	☐	→ *go on to question 16*
during the day only	☐	→ *go on to question 16*
during the night only	☐	→ *go on to question 16*
only for eating	☐	→ *go on to question 16*
only in company	☐	→ *go on to question 16*

14. If you stopped wearing your dentures, can you say how long ago you still wore them?

0 - 6 months ago	☐
7 - 12 months ago	☐
13 - 24 months ago	☐
2 - 5 years ago	☐
more than 5 years ago	☐

15. Why did you stop wearing your dentures?

my dentures are broken ☐
a tooth is missing from my dentures ☐
my dentures are worn out ☐
I don't like the way my dentures look ☐
my dentures were hurting me ☐
my dentures were coming loose ☐
I had trouble talking ☐
I had trouble swallowing ☐
I had trouble eating / chewing food ☐
I was advised to stop wearing them ☐
another reason, viz.:_____
_____

16. If a denture is coming loose, it can be given a new lining to make it stay in better. Have your dentures been given such a lining during the past 5 years?

yes ☐
no ☐ → *go on to question 18*

17. For this treatment, did you visit a dentist or a dental technician?

dentist ☐
dental technician ☐

18. In some cases, when dentures are coming loose, dental implants (artificial tooth roots) can be placed in the jaws to give the dentures more retention. Did you have such implants placed during the past 5 years?

yes ☐
no ☐ → *go on to question 20*

19. Did you go to a dentist or to an oral surgeon for these dental implants?

dentist ☐ → *go on to question 22*
oral surgeon ☐ → *go on to question 22*

20. Did you ever consider the possibility of having dental implants placed?

yes ☐
no ☐

21. Did you ever discuss with a dentist this possibility of having dental implants placed?

yes ☐
no ☐

22. How satisfied are you generally with your dentures?

very satisfied ☐ → *go on to 25*
satisfied ☐ → *go on to 25*
neither satisfied nor dissatisfied ☐ → *go on to 25*
dissatisfied ☐
very dissatisfied ☐

23. What is your most important reason for being dissatisfied with your dentures? Please mark only one answer.

my dentures are broken ☐
a tooth is missing from my dentures ☐
my dentures are worn out ☐
I don't like the way my dentures look ☐
my dentures are hurting me ☐
my dentures are coming loose ☐
I have trouble talking ☐
I have trouble swallowing ☐
I have trouble eating / chewing food ☐
another reason, viz.:_____
_____

24. What is the most important reason you have not yet asked for denture treatment, in order to remove your dissatisfaction? Please mark only one answer.

I can't face the treatment	☐
I have had some bad experiences in the past	☐
it is too expensive	☐
I don't think it can be treated	☐
I live too far away from the dentist/prosthesist/technician	☐
I don't care	☐
I don't have the time	☐
I didn't know it could be treated	☐
I thought it was too early for treatment	☐

another reason, viz.:_____

_____

25. You have come to the end of the questionnaire. Thank you very much for your cooperation!

You can use the enclosed return envelope to send us your completed questionnaire; no postage is required.

Curriculum vitæ

1975–1981	Christelijk Lyceum Arnhem;
1981–1986	Studie Tandheelkunde: Katholieke Universiteit Nijmegen.
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Aspects of dental health in Dutch adults; changes and consequences
WL Willemsen

Arnhem, 1994

1 In bevolkingsonderzoeken kan met behulp van "zelfbeoordeling" van de gebitssituatie een overzicht worden verkregen van de algemene gebitsgezondheid.

2 Het nut van computer-simulatiemodellen uit zich vooral in de onverwachte resultaten.

3 Het verzamelen van longitudinale gegevens is uitputtend voor participanten en onderzoekers.

4 In vergelijking met composiet is, voor de algemene gebitsgezondheid, amalgaam zo slecht nog niet.

5 Edentaat worden is niet besmettelijk, maar — als men naar relaties kijkt — wel aanstekelijk.

6 De term "zenuwbehandeling" doet vaak meer recht aan de gevoelens van de behandelaar dan van de behandelde.

7 Bij de huidige verwijsroutine hebben niet alleen tandartsen voordeel van een vervolgopleiding Endodontologie.

8 Te vaak is "obliteratie" het excuus voor het nalaten van een wortelkanaalbehandeling.

9 Onderwijs is als koken: ook al houd je ervan en stop je er veel energie in, als de ingrediënten niet goed zijn, wordt het nog niks.

10 Grote monden hebben geringe inhoud.

11 Het voor verkeerslichten ingeburgerde synoniem gaf het effect weer.

12 Kale mannen vergrijzen niet.

13 Door het oog van de naald zie je de hemel.

14 "But I know you're with me, whatever I go through"
Bruce Cockburn: Nothing but a burning light, 1991.

15 Meestal is het slot het einde.

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